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ABSTRACTS

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Compiled by: **James Wheely**
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Fussy eaters in the Burgess Shale: using optimal digestion theory to constrain the feeding ecologies of Burgess animals

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One of the most outstanding features of the Burgess Shale preservation is that the majority of the animals are found with partially or fully preserved digestive tracts. The occurrence of gut contents in the digestive tracts gives direct evidence of what the animals were ingesting, but unfortunately these are relatively rare. Most ecological studies of the Burgess animals have therefore focused on understanding and interpreting the external functional morphology of the creatures and how this relates to feeding strategy. However, the external morphology can be seen as a 'fine-tuning' of the digestive strategy, the main constraints on feeding are imposed by the internal digestive system. Optimal digestion theory is the idea that animals' gut systems are designed to process the food which they eat in the most efficient way. Thus, their digestive strategy should be directly reflected in their gut architecture. Using this as a tool, the morphologies of the Burgess guts are being studied to determine their digestive constraints and to give new interpretations of their feeding ecologies based directly on their internal digestive systems.

The shape of a species: morphometric analysis of the conodont apparatus

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As with other fossil vertebrates, a sound understanding of skeletal morphology underlies most facets of research into conodonts. Whilst traditional, qualitative description provides the foundation upon which the current understanding of this morphology rests, there are many examples where the complex variability of skeletal elements confounds analysis. Here, quantitative morphometric analysis may be the only means of rigorously evaluating element morphology.

First, a methodology must be developed to evaluate the robustness of morphometric techniques; this will be achieved using the conodont species *Ozarkodina excavata*, which provides a good example of the uncertainties that can arise in traditional morphological analysis. The taxon displays unusually extensive morphological variability for a single species; morphometric analysis of the skeleton of *O. excavata* has constrained this "intraspecific" variation, which is then quantitatively compared with variation in elements from other parts of the *O. excavata* spatiotemporal range to determine the nature and significance of any trends and differences present, also testing the monospecificity of the hypodigm. Ultimately this will clarify the taxonomy of the species, further elucidate conodont palaeobiology and allow testing of evolutionary models.

The systematics of the trilobite family Lichidae Hawle and Corda, 1847

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The first cladistic analysis of the trilobite family Lichidae Hawle and Corda, 1847 is presented. Thirty lichid genera and five lichakephalid outgroup taxa were coded for forty-nine characters using published descriptions (principally Thomas and Holloway 1988, Adrain 1994, and Holloway and Thomas 2002). The Lichidae is shown to be monophyletic. The taxa placed in the Trochurinae (Holloway and Thomas 1988) are well supported by several synapomorphies in a single clade in the strict consensus tree. Other groups are also supported (e.g. Tetralichinae, Echinolichinae and Platylichinae); a few, however, are not (e.g. Homolichinae, Lichinae). The degree of homoplasy found in the dataset (CI=0.4778) is of similar value to that found in similar-sized trilobite datasets; the level of homoplasy among the Lichoidea is not unduly high, relative to that of other trilobite groups. Although bootstrap and branch support values are low, the strict consensus tree is well resolved.

Exploring skull evolution in Rhynchocephalia

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The Rhynchocephalia, are a group of small diapsid reptiles that were very successful and widespread during the Mesozoic but today the Tuatara, *Sphenodon*, from New Zealand is the sole representative. Recent work has revealed an unexpected degree of diversity in skull architecture and feeding apparatus in a group traditionally thought to be conservative. Basal taxa (e.g. *Gephyrosaurus*) posses a relatively simple pleurodont dentition teeth, a divergent lateral palatine tooth row, and an incomplete lower temporal bar. More derived genera exhibit a trend towards a fully acrodont dentition, a more parasagitally aligned palatal tooth row, fewer teeth, and, in some lineages, the reformation of the lower temporal bar. These changes are allied with the development of one of two sophisticated shearing mechanisms: either orthal (e.g. clevosaurs) or propalinal (e.g. *Sphenodon*, *Priosphenodon*). To explore these apparent trends we used Morphologika, a geometric morphometric programme. Through Principle Component Analysis this identifies associated shape changes in cranial structure which can be illustrated using thin plate spline deformation grids. Results demonstrate alterations in rostral and temporal lengths, orbit size, parietal width, and the structure of the lower temporal bar and squamosal.

Exceptionally preserved Eocene fossil plants from Antarctica: palaeoclimatic, biogeographic, & evolutionary significance

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Exceptionally well-preserved fossil plant material has been collected from the Eocene La Meseta Formation (approximately 50Ma) on Seymour Island, Antarctic Peninsula. At this time, despite being over the South Pole, Antarctica was covered in forest vegetation before a dramatic climate change caused the onset of the modern icehouse world. This Antarctic flora is a valuable record of past greenhouse climates and is especially relevant for predicting the effects of the recent global warming.

The plants are preserved in concretions within volcaniclastic marine shallow-shelf sediments. Much of the material has been permineralised by volcanic-related fluids, and these fossils form the basis of my PhD research project, which I began in October 2003.

The flora is dominated by conifer material of the genus *Araucaria* (e.g. Monkey Puzzle trees). The fossils include intact conifer branches preserved in three dimensions with their leaves still attached, as well as isolated conifer leaves and cone-scales, and woody fragments. Many of the leaves have been permineralised by delicate mineral layers which display cellular detail and stomata, but fossils also occur as impressions and casts. Several types of angiosperm leaves are also preserved.

Leaf stomata are so well-preserved that Eocene values of atmospheric-CO_2 concentration can be calculated using stomatal density analysis. These new values of CO_2, plus other palaeoclimate information deduced from the fossil plants, will be used to test computer-generated models of the Eocene Antarctic climate.

Modern *Araucaria*, with their distinctive canopies, are only found in the Southern hemisphere where they typically grow in disturbed environments on poor soils. They form both dense and open forests in volcanically-active areas, like the Chilean Andes. The Eocene araucarian conifers grew in comparable habitats on the Antarctic Peninsula which, during the Eocene, was an active volcanic arc.

High Latitude Late Jurassic and Early Cretaceous Climates

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The Jurassic and Cretaceous Periods have long been considered a time of great warmth, where high temperatures prevailed over both equatorial and Polar Regions, and where the formation of polar ice was therefore unlikely. Recent evidence has however, demonstrated the presence of glendonites, tillites and dropstones in Northern high latitudes and hence provided at least equivocal evidence for ice-house phases in the Early Cretaceous.

Unfortunately, such evidence is both spatially and temporally limited, with a particular emphasis on Southern high latitudes. This scarcity of data is particularly significant, as it is generally acknowledged that global climate is defined to a considerable degree by the prevailing conditions at polar latitudes.

The major purpose of this research is therefore to assemble an array of geological data from biostratigraphically constrained localities in Northern Europe, Siberia and Svalbard, principally by sedimentary logging and macrofossil collection (primarily of belemnites). Macrofossil and geochemical analyses will be used to generate new evidence for the patterns and consequences of changes in Late Jurassic and Early Cretaceous oceans, climate and sea level. The resulting data will also provide information on belemnite palaeobiogeography and provinciality.

Systematics and phylogeny of the *Stegosauria*

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Understanding the systematics and phylogeny of the stegosaurian dinosaurs is an important aspect of the phylogeny of the ornithischians as a whole. Although several papers were published in the 1980s describing various specimens, the focus of these was pure description and no attempt has been made to use a systematic approach to classify the material into clades based on diagnostic characters that can be applied to even the most fragmentary material, and repeated by later workers. As a result, the relationships within the group are unknown. The aims of this project are to review the known material, and to carry out a cladistic analysis in order to get a better understanding of the interrelationships within the clade. So far, the European stegosaurian material has been reviewed. Previous work has suggested that two genera are present in Europe, *Lexovisaurus,* with two species, and *Dacentrurus,* which is monospecific. Recent finds, however, seem to suggest that the two species of *Lexovisaurus* can be synonymised into one: *Lexovisaurus durobrivensis,* and the single species of *Dacentrurus* shows a great deal of variation and may actually represent at least two species.

Mesozoic scorpions from South America

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The fossil record of scorpions of Mesozoic age from South America is fragmentary. From the Crato Formation (Lower Cretaceous, Brazil) only two species are recorded: *Araripescorpius ligabuei* CAMPOS and *Protoischnurus axelrodorum* CARVALHO AND LOURENÇO (Protoischnuridae, Scorpionoidea). During recent fieldwork in Nova Olinda, Ceara', two specimens were collected, which probably belong to one of these species. However, they have wonderfully preserved cuticles, keels, chelae and spiracles, thus showing additional somatic features not previously described. Morphological and morphometric interpretation of additional specimens, belonging to both species, suggests that the family Protoischnuridae is very closely related to the recent Liochelidae and that *Araripescorpius*, previously not assigned to a family, probably belong to Chactidae.

New information on the ornithischian dinosaurs of the Elliot Formation (Late Triassic-Early Jurassic) of Southern Africa

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The Elliot Formation of South Africa and Lesotho is Late Triassic – Early Jurassic in age, and gives us one of our best insights into understanding the early evolution of the ornithischian (bird-hipped) dinosaurs. A review of the collections of the Natural History Museum, London, and various South African museums has allowed the tentative recognition of two new taxa of basal ornithischians (including the most complete Triassic ornithischian), adding significantly to the early diversity of the group. Ongoing work involves a comprehensive revision and reanalysis of the current, extremely oversimplified, phylogeny of the Ornithischia.

Taphonomy and taxonomy of new Silurian xiphosurans from Iowa

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A new genus and species of synziphosurine (Chelicerata: Xiphosura) is described from a new Lagerstätte dated as Wenlock-Ludlow? in Clinton County, Iowa. It is characterised by a sub-triangular, rounded carapace, ten opisthosomal segments divided into a preabdomen with seven and a postabdomen with three, and tuberculate ornament on the carapace and pleural margins. Exceptional preservation of muscle tissue in the specimens has implications for the phylogeny of synziphosurines, a rare and poorly-known stem-group of xiphosurans. The muscle tissue is compared with that in a new, exceptionally preserved, specimen of the Jurassic xiphosuran, *Mesolimulus walchi*, from the Nusplingen Lagerstätte, Germany. Modern xiphosurans, such as *Limulus polyphemus*, differ very little from *Mesolimulus*, leading to their description as a "living fossil". This has allowed the identification of individual muscle groups in the new specimen of *Mesolimulus* comparable to those of *Limulus*. S.E.M analysis has revealed individual muscle fibres, preserved in apatite, which frequently show banding due to partial decay of the soft-tissue.

Exceptional Preservation in the Upper Carboniferous Coseley Lagerstätte

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The Late Carboniferous Coseley Lagerstätte from the West Midlands, UK, contains exceptionally preserved plant and animal fossils that occur as hard parts and mineralised soft tissues sealed within siderite nodules. The nodules vary in size from 15 mm to 250 mm and are spherical to oval in shape. The nodules are recovered from Westphalian B siltstones and mudstones of the Coal Measure Group and were abundant enough in these horizons to form commercial ironstone beds.

The Coseley fossils have been examined using various techniques including scanning electron microscopy and point analysis, which have revealed several distinctive phases of preservation: soft tissues have been replaced by kaolinite, voids have been extensively filled with sulphide minerals, all of which are then encased in siderite concretions. Bacterial mediation has allowed the authigenic growth of very fine-grained clay minerals on the surface of the decaying organisms, templating the soft tissues and forming biofilms that preserve fine anatomical detail. This was accompanied by early framboidal pyrite formation and closely followed by void filling sphalerite, galena and pyrite precipitation. Siderite formation would have either occurred during or shortly after soft tissue preservation producing a concentric nodule that prevented compaction of the fossils.

Why is the Biostratigraphy of the Durness Group so bad?

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The Durness Group consists of some 750 m of carbonates of Cambro-Ordovician age. These carbonates overly the clastic Eriboll and An t-Sròn formations. The age of these underlying units is fairly well constrained and the fauna (*Olenellus* and *Salterella*) shows that the rocks can be correlated with the Lower Cambrian *Bonnia–Olenellus* Zone (of North America).

Some confusion still remains as to the age of a large part of the Durness Group. A complete lack of fossils of Middle and Upper Cambrian age has led many to postulate an unconformity. There are some 200 m of barren peritidal dolostones, and these may be of Middle and Upper Cambrian age. Fossils in the rest of the group are rare and the poor preservation makes identification less easy. Conodont data for the Durness Group up till now has been patchy, and new records are starting to give much higher resolution for the ages of the different formations within the group.

The apparatus architecture of *Erismodus quadridactylus* (Stauffer) and its implications for the evolution of the prioniodinids.

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The apparatus composition and architecture of prioniodinid conodonts is poorly understood. This is mainly due to the lack of natural assemblages, where all, or most, of the elements, which make up the apparatus of a single individual, are found in close proximity. These *in situ* assemblages often reflect the original architecture of the species. An excellently preserved natural assemblage of *Erismodus quadridactylus* (Stauffer), a prioniodinid, found in a core from a borehole in North Dakota, USA, will add key information to the architecture and evolution of prioniodinids. A study of the elements is underway and a three-dimensional representation of the apparatus will be constructed. The assemblage is providing some significant insights into the apparatus architecture of the genus *Erismodus,* in particular revealing that certain element morphotypes traditionally considered to be within the main ramiform basket lie elsewhere in the apparatus. *Erismodus* along with most other prioniodinids has a very fluid morphology and hence an exceptional fossil such as this assemblage will help to define the apparatus architecture and refine the species concept of the prioniodinids.

A new eurypterid fauna from Norway and *Eurypterus* phylogeny

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A new eurypterid fauna from Sønsterud farm, Ringerike, Norway was discovered early in the summer of 2001. It comprises a new species of *Eurypterus*, a possible new species of *Pterygotus* closely related to *P. anglicus*, *P. atlanticus* and *P. carmani*, brachiopods (*Lingula* sp.), ostracods (*Leperditia* sp.) and very rarely cephalopods (orthocone nautiloids), bivalves and gastropods. Common thelodonts and rare conodonts in over- and underlying beds constrain a Wenlock age for the fauna. The two species of *Eurypterus* from the Pentland Hills fauna of Scotland (Llandovery) were borrowed for comparative purposes; *E. minor* is the oldest representative of the genus in the fossil record, while '*E*'. *cyclophthalmus* is a stylonurid (eurypterids with walking legs). A phylogeny of *Eurypterus* and *Baltoeurypterus* species suggests that *Baltoeurypterus* is an in-group of, and therefore should be included in *Eurypterus*. The phylogeny further suggests the new species to be relatively basal in the clade.

Eurypterid phylogeny (abstract for poster)

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The result of the first parsimony analysis of eurypterids suggests that those with walking legs (‘Stylonurina’) are more basal than the swimming forms (Eurypterina), and that Eurypterina is a monophyletic group. Pterygotids form a monophyletic group at the top of Eurypterina. Furthermore, the results show that there is no way of dividing Eurypterina into two monophyletic suborders, as both of the two current competing hypotheses suggest. A division into Pterygotina (forms with enlarged chelicerae) vs. ‘Eurypterina’ (in the sense of forms with small chelicerae), renders ‘Eurypterina’ paraphyletic in this model. A division into Eurypterina (in the sense of forms with the sixth appendage developed into a swimming paddle) vs. Stylonurina (forms with the sixth appendage developed as a walking leg) renders Stylonurina paraphyletic. However, a number of monophyletic superfamilies and families can be recognised.

Graptogonophores, scopulae and Dawsonia: graptolite reproductive organs or a load of old balls

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Vesicular structures on graptolites, for example scopulae s.l., have attracted considerable interest and debate. For most of the nineteenth century they were considered to be reproductive organs, similar to those of modern hydrozoans, and termed graptogonophores. Despite the increasing acceptance of a hemichordate affinity for graptolites in the twentieth century, the proposed reproductive function of scopulae remained largely unchallenged, and latterly overlooked. Isolated sclerites from problematic fossil Dawsonia, have previously been regarded as detached scopulae, though morphometric analysis shows that the similarity is superficial.

This work reassesses these structures and suggests, by comparison with demonstrably vesicular graptolite tissues, that scopulae s.s. are best considered to be two-dimensional paddle-like appendages of hydrodynamic function. These are restricted to the diplograptids, presumably a unique acquision that facilitated the colonisation of a niche habitat by the clade that eventually gave rise to the retiolitids. Their two-dimensional nature denies the supposed reproductive function, leaving the term graptogonophore obsolete. Their inferred mode of construction requires a large, extremely mobile zooid if the Rhabdopleuran model of periderm secretion is correct.

The Phylogenetics of the Basal Diapsids - Positions of the Prolacertiforms and Pterosaurs

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Modern palaeontology relies on cladistic methods to produce hypotheses of relationships between taxa. Large-scale efforts use either Supertree or Total-Evidence methods, though each has problems associated with their use. By combining the results of recent publications on pterosaurs and prolacertiforms, the two methods are evaluated in their resolution of conflicting data. The results demonstrate that caution needs to be exercised in using either method.

Scratches in the rock: what can they tell us?

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The Lower Permian Robledo Mountains Formation of southern New Mexico, USA, contains one of the most diverse terrestrial ichnofaunas in the world, and represents a broad tidal flat with little marine influence. The vertebrate ichnofauna has been well documented and comprises trackways attributable to amphibians, reptiles, and pelycosaurs; conversely, the invertebrate ichnofauna has received comparably little attention and is dominated by non-marine arthropod trackways of chelicerates, myriapods, and insects, as well as insect resting and jumping traces.

New reports of vertebrate ichnotaxa include the fish trail *Undichna* and the amphibian swimming trail *Lunichnium*; whilst those of invertebrate ichnotaxa include a series of radial scratches assignable to *Striatichnium*. An entire preservational morphocline of imprints attributable to the apterygote insect jumping trace, *Tonganoxichnus robledoensis*, can be demonstrated, ranging from just two imprints of the palps to a complete body imprint.

Tracksites of a similar age to the Robledo Mountains are abundant throughout New Mexico, and represent a transect of environments from alluvial fans in the North to tidal flats in the South. Data from more extensive collecting of such sites for invertebrate trace fossils will be incorporated into the already existing data set for the vertebrate ichnofauna to provide a more holistic view of the paleaogeographic and palaeoenvironmental distribution of animals during the Lower Permian of New Mexico.

Perispore – an overlooked feature in pteridophyte reproductive biology? Some answers as well as ongoing mysteries

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Coined by Russow in 1872, the term *perispore* is currently defined as "the outer wall of the sporoderm consisting of material distinct from the exospore sporopollenin, and formed later than the exospore, as in the homosporous Filicopsida" (Tryon and Lugardon 1990). This, however, is only one definition of many and spore wall terminology has been used inconsistently for decades. Development, function, evolution and chemical composition of this outer spore layer are unknown and to the present no clear overall picture of this structure has been drawn.

New insights into this challenging feature are presented as well as ongoing mysteries discussed.
The following bullet points are questions/ideas that will be addressed during the talk but can also form the basis for some further discussion.

- Where are inconsistencies in terminology?
- What is known about the occurrence of the *perispore* in the fossil record?
- How can the *perispore* be distinguished from the exospore and which methodologies can be used for chemical analysis?
- Which role does silica play in spore walls of pteridophytes?

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Bohemian bivalves: a taphonomic investigation

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Mollusc shells (along with others) would form a thick accumulation across the seafloor if it were not for their removal by destructive taphonomic processes of the taphonomically active zone (e.g. bioerosion, abrasion, and dissolution). Dissolution, an early burial diagenetic process, driven by oxidation of organic matter, has proven to be much more significant in originally aragonitic dominated shelly faunas from the Silurian and Jurassic than previously realised. Liberated molluscan aragonite is proposed to be involved in the formation of diagenetic limestone-shale sequences. Only where dissolution processes are halted, through e.g. early lithification or rapid burial, are molluscan components preserved. Fieldwork to test these hypotheses is planned on the bivalve rich limestone-shale sequences of the micritic limestone facies of the Silurian and Devonian Kopanina and Pozary Formations of the Prague Basin. This is a Sylvester Bradley Award Research Project 2004.