BEER'N'BONES

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FLINDERS UNIVERSITY PALAEONTOLOGY SOCIETY

MESSAGE FROM THE PRESIDENT

G'day Folks,

The holidays are often a time when everything is put into perspective. All those afternoons sitting at the beach or drinking a beer on the porch allow you to reflect on what's happened over the last 12 months. However, while you can often be pretty chuffed with the general shape of things, it can also tell you where you're falling short. And when Grandma tells you over the phone that you haven't put out a 'BEER'N'BONES' in a while, well, you've just got to listen.

The last year though has meant a lot of things for the society, and this issue covers a number of them.

Earlier in the year a few of us wondered down to Naracoorte, where Amy was conducting her honours project, and she's given us a wrap up of her results. We have also had a resumption of the Alcoota trip which James has dusted himself off from, and covered for us. There's also the regular stuff; some dinosaurs and dates, as well as a dash of science fiction for some reason. There's also an interview with Gilbert Price, a Queensland palaeo, and expert on dating and palaeoecology who some of us were able to catch giving a talk during science week at Naracoorte.

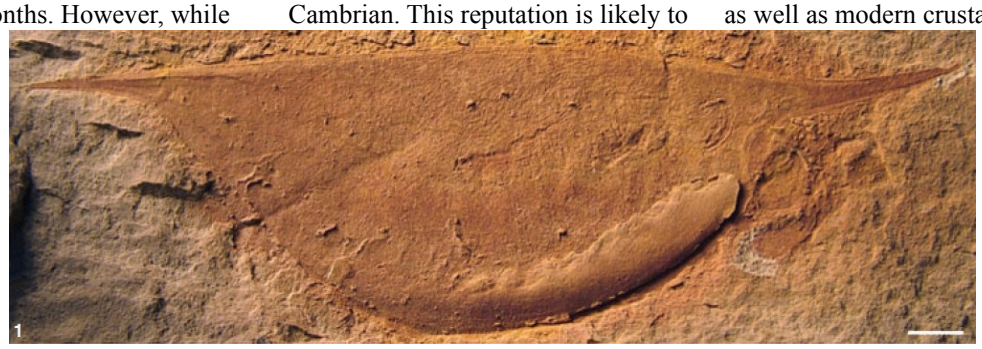
Well, the holidays are almost over, so I guess I better get started.

See y'all,
Sam
Palaeoprez

OLD NEWS

CAMBRIAN ARTHROPODS LOOK MEAN

Emu Bay, Kangaroo Island, has since the 1960s been steadily accumulating both fossils and reputation worldwide, establishing itself as a site of importance in understanding the lower Cambrian. This reputation is likely to be furthered by the description of a number of soft tissue characters, which appends our knowledge from other sites, including the famous Burgess Shale of British Columbia. The discovery concerns two species; *Isoxys communis,* and *Tuzoia australis,* both of which are well known arthropods that have been found throughout the world. They are considered to be closely related to one another, but their relation to other arthropods remains unclear. The new finds however are able to append current understanding by adding a number of rarely fossilised soft-tissue characters, as well as a more detailed understanding of the hard anatomy of the creatures.



One of the Isoxys communis *specimenswith soft tissue preservation. A preserved eye can be seen on the centre right. The scale bar represents 5mm.*

Among the new characters found in *I. communis* are the possession of large, stalked eyes, giving the creature the largest eye size relative to body size found in the Cambrian. This is thought to suggest that *I. communis* is likely to be a predatory species, with the larger eye size hypothesised to assist in locating and chasing prey. This finding also fits other morphological features of the species, particularly its large raptorial appendages. Both species also showed possession of midgut glands, a trait that is considered to signify predation, by its ability to increase absorption and digestion, particularly of infrequent meals. This has been noted in other fossil arthropods previously, as well as modern crustaceans and chelicerates. The two species also featured reticulation of the carapace, which is an adaptation allowing for the reduction of weight of the carapace while retaining strength. This too was thought to indicate an adaptation to allow for easier movement, and has again been found in many other free swimming organisms. Overall these structures indicate what is likely to be predatory lifestyles. Furthermore they have highlighted the potential for the Emu Bay Shales to become among the most important Cambrian Sites in the world, and contribute to our knowledge of this important time in geological history.

Sam Arman

García-Bellido, D., Paterson, J.R., Edgecombe, G.D., Jago, J.B., Gehling, J.G., Lee, M.S.Y., (2009), The bivalved arthropods *Isoxys,* and *Tuzia* with soft-part preservation from the lower Cambrian Emu Bay Shale Lagerstätte (Kangaroo Island, Australia), *Paleontology*, vol.52, no.6, pp1221-1241

DIGGING DINOSAURS

Three geological features, discovered just 6 kilometers from 'Dinosaur Cove' in Victoria, appear set to greatly develop our understanding of the behaviour of the animals of the region. The features appear to be dinosaur burrows, primarily due to their similarity to burrows previously discovered in the lower Cretaceous of North America. This similarity is of interest as the American discovery also contained the remains of a small ornithopod within it.

The features consist of sandstone infilling structures, the composition and morphology of which is considered to be extremely unlikely to have been formed by natural geological processes. They exist in what has been interpreted to have been an alluvial fan, with sharp contacts between that and the infilling sands indicative of a fast infilling process. Morhologically they are shallowly inclined cylindrical tunnels with a diameter of ~30cm, with one structure containing two turns and a larger terminal channel. The longest of the structures has a total length of 2.1m. The shape considered likely to be able to house a small ornithopod, such as that found in the North American discovery as well as a number of forms found in the nearby Dinosaur Cove deposits. It also cannot be attributable to any other forms, such as mammals and labrinthodont amphibians found in the region.

This was done by the use of body size estimates, the ability to tunnel of the animals concerned, and body shape, which will affect the animals ability to make the turns necessary to enter the burrows. The structures also lie near a dinosaur trackway, which has been attributed to either a ornithopod or theropod based on shape.

This discovery also may provide further insight into the adaptations of the animals to the palaeoenvironment in which the dinosaurs lived. Past work on the dinosaurs of the region have been largely focused upon how the dinosaurs were able to survive what would have been long dark Antarctic winters. A variety of analyses have suggested that the region is likely to have laid at 78±5°S, with annual mean temperatures ranging from -6 to +8°C. The abundance of smaller forms such as ornithopods in the region had been somewhat confusing, as colder environments generally favour larger species due to changes in the surface area to volume ratios in what is known as Bergmann's Rule. If burrowing behaviour is shown however, the smaller species will be favoured as the energy expenditure in burrowing is relatively lower for smaller animals, and generally limits the size of fossorial, or burrowing animals. Smaller animals are also less favoured to long migrations, and as such any strategies to reduce heat loss will be beneficial in surviving the cold winter months, and burrowing has been found in many smaller extant Arctic animals. This also fits other anatomical adaptations that appear to suggest continuous, year-long activity in ornithopods. If burrowing behaviour is implied, it is then also possible to envisage other associated traits, such as huddling and food storage which could also help alleviate the winter cold.

Artists reconstruction of the burrow.

Sam Arman

Martin, A.J., (2009), Dinosaur burrows in the Otway Group (Albian) of Victoria, Australia, and their relation to Cretaceous polar environments , *Cretaceous Research*, vol.30, pp1223-1237

BASAL BANDICOOTS AND BIOCORRELATION

A new species of bandicoot has been described from Kangaroo Well, a limestone formation south of Alice Springs in the Northern Territory. The species has been named *Yarala kida*, with 'kida' meaning father in the language of the Mudbra people. This refers to the inferred phylogenetic position of the species within the Peramelemorphia as representing the ancestral or plesiomorphic condition. This is, as earlier authors have stated that features of the Yaraloidea suggest it to be plesiomorphic, and further that *Y. kida* may be plesiomorphic to the Yaraloidea itself.

Based on biocorrelation, the assemblage at Kangaroo Well has been considered to be late Oligocene in age. It has been suggested that this, in combination with the species basal condition, may then provide an opportunity to use the species as a biological marker for future work. This will be of use, as previously existing biological markers are currently based on diprotodontid lineages, which are rare. The timing of the inferred speciation also subdivides the currently existing faunal horizons Large stockpiles of as yet unstudied bandicoot material from a number of approximately contemporaneous deposits will help ascertain the legitimacy of *Y. kida* as a biochronological marker.

The diet of the species is considered to be insectivorous-carnivorous, based

on comparison of dentition with other species, and relative crest length measurements.

Sam Arman

Schwartz, L.R.S., (2006), A new species of bandicoot from the Oligocene of Northern Australia and implications for correlating Australian tertiary mammal faunas, *Palaeontology,* vol.49, part 5, pp991-998

SAVED BY THE BILL

Tracing the phylogeny of the monotremes, (platypuses, echidnas ect.) is of considerable interest to many biologists. This is due to both their inherent weird coolness, as well as their position as evolutionary intermediates, or even as some have proclaimed, as living fossils of mammal like reptiles (M. McDowell, pers.comm). Tracing this phylogeny though has traditionally been difficult, simply due to the sparsity of species both modern and extinct. An attempt to better understand this phylogeny though has been undertaken by utilising a combined molecular (of extant species) and morphological (extant and extinct species) characters. The result of this has seen considerable re-evaluation of monotreme phylogeny, particularly in the relationship of fossil to modern lineages. F
Firstly though, a couple of fossils of interest must be introduced which are of primary importance for this study. The first is *Teinolophos trusleri*, from Flat Rocks in Victoria, and aged at between 112.5-121 ma. The second of which is *Steropodon galmani*, an ~105ma fossil, spectacularly preserved in opal from Lightning Ridge, NSW. Previous studies had assigned these two species to platypus lineages (to the exclusion of echidnas) on the basis of the possession of a few related characters. This finding should not be skimmed over however, as it would implies that these lineages have been distinct for over 100 ma. More recent molecular analyses though are not quite as incredible, and generally place the divergence within the tertiary (<65ma).
By utilising a number of genes in combination with fossil calibration points, the new phylogeny estimated the divergence of living monotremes to occur between 19 and 48 ma, well into the tertiary. Re-analysis of morphological characters also support this view, as well as providing further, subtle indicators of the placement of *Teinolophos* and *Steropodon* well outside the modern monotreme lineages.
The reanalysis also puts to bed other anomalies suggested by the previous analyses. These suggested abnormally fast molecular divergence to initially separate the platypus and echidna lineages, while maintaining slow molecular evolution from there onwards to allow for the current similarity of the echidna-platypus genetics.
The study also suggests the means as to why the initial analyses placed *Teinolophos* and *Steropodon* with modern platypuses. They suggest that the condition found in these groups represent the ancestral monotreme condition, which has subsequently been lost in echidnas, and probably associated with the development of the distinctive reduction of echidna jaw bones 'to little more than elongate splints' (Phillips et.al., 2009, p17093). This evolutionary sequence is also suggested by fossil evidence, which show platypus-like ancestors such as *Monotrematum* well back into the tertiary, with no echidna ancestors being found beyond the mid-tertiary. The evolutionary sequence also implies the evolution of a terrestrial animal from a semi-aquatic forbearer. This in itself is also of interest as it has only been documented previously in mammals by elephants. This aspect of echidna evolutionary history can also be seen in their morphology, with a number of features such as dorsally projecting hindlimbs, and streamlined body shape, both of which would be advantageous to a semi-aquatic creature. Echidnas also feature a number of other platypus-like features such as an embryological bill and (non-venomous) ankle spurs, which suggest a more recent evolution from a platypus-like ancestor.
As if all of this isn't enough, the study even suggests that the bill may be an ancestral monotreme condition, and as such may have given the monotremes competitive advantage over other mammals. This is due to 'mam' in mammals necessary suckling of nipples placing constraints on the types of mouthparts that could evolve. As monotremes receive their milk via glands, they are then able to form unique mouthparts, enabling them to specialise into unoccupied niches, which may have helped them survive for long enough to confuse palaeontologists and naturalists since their discovery.

Fossil monotremes; the opalised Steropoon *left, and slightly less impressive* Teinolopphos*, right.*

Sam Arman

Phillips, M.J., Bennett, T.H., Lee, M.S.Y., (2009), Molecules, morphology, and ecology indicate a recent, amphibious ancestry for echidnas, *PNAS*, vol.106, no.40, pp17089-17094

REFINED DATING OF QUEENSLAND MEGAFAUNA SITES

As is becoming increasingly recognised, one of the most informative sources of data is that of refined dating, especially when applied to specific questions such as the megafauna. By aligning, or demonstrating non-alignment of the extinction to other factors proposed to have caused the extinction, researchers hope to produce a more coherent chronology of the extinction and the factors involved. This has been the task set upon by the team at the University of Queensland (see interview below), in reference to a number of sites in south-east Queensland. The importance of such becomes particularly appreciated when, as the team noted, earlier researchers cited the deposit as evidence towards a particular extinction hypothesis. Unfortunately, the excavation of many sites was undertaken before the true utility of dating techniques were fully recognised. To provide chronological context for such sites then, many sites must be revisited and dated. Sites were dated using Uranium-Thorium techniques on both enamel and stalactite straws which had been accumulated into he deposit. The results indicated that The Joint, within Texas Caves accumulated 291.6±7.2 to 29.0±0.1ka, from the bone breccia, with the latter being found on a *Macropus titan* tooth, a species which is considered by some, though not all authors as a distinct megafaunal form. An additional minimum age of 40.7±0.4ka for the deposit has also been indicated from the dating of calcite formations overlying the deposit. Russenden Cave Bone Chamber, also within Texas Caves also returned a comparable age for *M. titan*, with the date of 32.2±0.1ka providing a minimum age for the deposit, and a stalactite straw indicating a maximum age of 54.7±0.4ka. The final site, known as Cement Mills, Gore also dated two macropod teeth though the particular species was unknown but suggested to also be *M. titan*. These returned contemporaneous dates of 53.6±ka and 53.9±0.3ka.

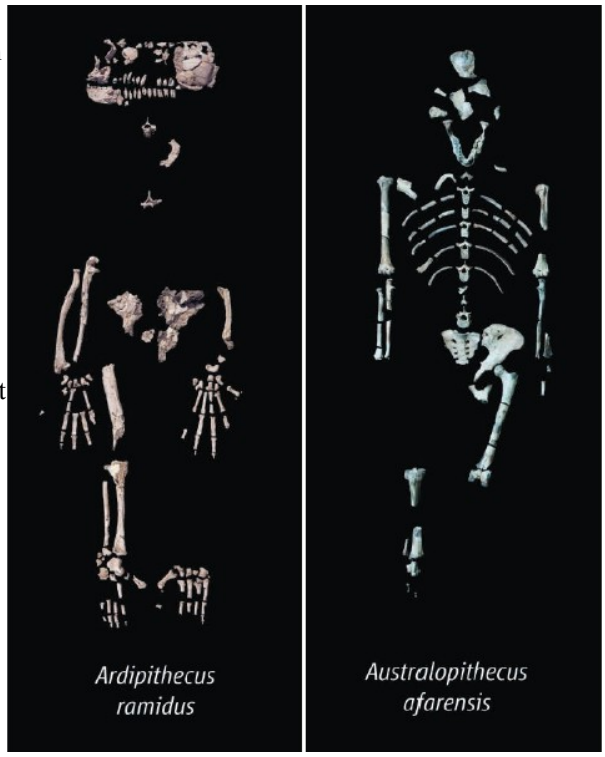
While these dates are enticing, there are a number of issues that may also effect the seemingly young ages for the 'megafauna' found at the two Texas Cave sites. Firstly, uranium uptake, which provides the initial source of uranium within the enamel used for dating, only occurs post-mortem, and as such the degradation to thorium will not be immediate. This uptake also occurs via a number of uptake modes, with delayed uptake being common for enamel. As the results from teeth are in contrast to both straw and calcite derived dates, this appears likely. There is also the issue of dating stalactite straws, which is a relatively new process, and will also skew the data, due to the discrepancy from straw formation and subsequent deposition within the deposit. The results may indicate a young age for megafauna, in *M. titan* in the region, a phenomena not unknown elsewhere, which also allows significant human-megafaunal overlap. With a limited data set of one questionably megafaunal species, combined with some methodological issues, it is probably safest to simply note these dates as preliminary, but important minimum ages for the deposits. What this study really presents, is how, beyond biocorrelation we can begin to reassess deposits to produce a much more detailed continent-wide chronology of the megafaunal extinction.

Sam Arman

Price, G.J., Zhou, J., Feng, Y., Hocknull, S.A., (2009), New U/Th ages for Pleistocene megafauna deposits of southeastern Queensland, Australia, *Journal of Asian Earth Sciences,* vol.34, pp190-197

ARDI

This article hardly requires a title, for unless you have spent the last six months in a cave (now there's an idea), you would have heard the name 'Ardi' a number of times. This is of course referring to *Ardipithecus ramidus*, a new hominid discovered in Ethiopia. The actual discovery of the species took place a number of years ago, however publication was delayed in the hope of discovering a more complete specimen. This has now occurred, with the type specimen consisting of an almost complete skeleton, including hands, feet and skull, with 125 bones in total, not including the 35 other individuals found to date.



'Ardi', left, meets 'Lucy', right.

The skeleton has been radiometrically dated at 4.4 ma, and provides a yet-further glimpse into hominid origins. Ardi stands at ~120cm tall, with a body and brain little larger than a chimpanzee. The comparison to both chimps and humans though reads much like an ideal intermediate form between the two species. The skull shape suggests that Ardi did not possess a protruding muzzle like a chimp, and male specimens (the type is female) possess smaller canines, which has been taken by some to

suggest that *A. ramidus* had less male-male aggression. Her feet show a a stiffening of bones for stability, as well as the retention of an opposable big toe, meaning that she likely both climbed trees as well as walking. Her hands seem to suggest that she neither knuckle walked or swung through trees, but also possessed long, curved fingers to assist in gripping branches. Ardi's shorter pelvis, by lowering her centre of gravity also suggests that she walked upright, but probably only faculatively These features are of particular interest as upright walking has, since 'lucy' (*Australopithecus afarensis*), been considered a defining feature of hominins. As Ann Gibbons (insert primate joke) stated, 'On this point, Ardi stands on shakier ground.' (2009, p1599).

Sam Arman

Gibbons, A., (2009), Breakthrough of the Year; *Ardipithecus ramsayi*, *Science,* vol.326, pp1598-1599

FEATURES

Palaeoecology of the Grant Hall Fossil Deposit, Naracoorte, South Australia: Research, Results and Reflections.

Getting started...

In 2009 I undertook my Honours degree in Palaeontology under the supervision of Drs Gavin Prideaux and Liz Reed. My project involved an examination of the palaeoecology of the Grant Hall fossil deposit of Victoria Fossil Cave, Naracoorte.

The opportunity to examine the Grant Hall fossil deposit was first raised with me by Dr Prideaux while on field work in Western Australia. I knew I wanted to undertake Honours in palaeontology, but up until then, was not sure of the exact nature of the question I wanted to address. The research potential of Grant Hall was enticing however; extensive taphonomic investigations by a former Honours student (Rebecca Gresham) had shown that the deposit represented a unique ecological community assumed to be associated with the peak of the penultimate interglacial ca. 125,000 years ago (Grün et al., 2001; Fraser and Wells, 2006). Climatic conditions during this time period were very warm and dry, with estimates of mean global temperatures 1 to 3°C higher than present (Ayliffe et al., 1998).

Speleothem column in the Grant Hall chamber and 2000 excavation pit.

By presenting a potential analogue to conditions we may expect to experience under future climate change scenarios, accumulation of the Grant Hall deposit over this interval provided an opportunity to examine the nature of ecological response to warm conditions associated with a peak interglacial event. It was also enticing to work on a site that may provide greater insight into the factors that contributed to the extinction of the megafauna. If megafauna were represented either side of the 125,000 interval in the Grant Hall deposit, then this would suggest that they were able to persist through changing climatic conditions.

After reviewing a wide range of literature and with the support of my supervisors, I developed a clear project design based on addressing five specific research aims:

(1) Determine the age profile of the site using Optically Stimulated Luminescence (OSL) dating in order to test the hypothesis that the site accumulated rapidly over the peak of the last interglacial. The Grant Hall fossil deposit is constrained between two layers of flowstone that were deposited 220,000 and 76,000 years ago, as determined by Uranium series dating (Ayliffe and Veeh, 1988). Electron spin resonance dating of tooth enamel from the site provided the age of 125,000 years (Grün et al., 2001). And to make life really interesting, an OSL dated sediment sample from the deposit reported an age of 84,000 years (Roberts et al., 2000). Clearly, resolving the accumulation age of the site was a priority.

(2) Determine the number and character of depositional units across the stratigraphic profile based on grain size, shape, geochemistry and depositional age. Initial research by Gresham (2000) identified three depositional units characterised by homogeneous dark red-brown clayey sands. Prior to commencing my own excavation of the site I studied the exposed stratigraphic profile and identified six potentially independent depositional layers, contrasting with the three identified by Gresham (2000). The extensive sedimentary analysis detailed above was designed to test the validity of this inference.

(3) Measure $^{13/12}C$ and $^{18/16}O$ isotope ratios in fossil tooth enamel across the deposit to provide insight into local

Early days... photo courtesy of Steve Bourne (2009)

environmental conditions (vegetation type and moisture conditions) over the history of accumulation.
(4) Determine if there is change in the mammal faunal assemblage composition, species richness and species relative abundance across the deposit, and
(5) Examine the relationship between the fossil assemblage and environmental conditions provided from the deposit and relate this to major climate and ecological change over the Middle to Late Pleistocene both regionally and globally. The aim of this was to examine the validity of the 'resilience hypothesis' in relation to the megafauna extinction debate by determining the nature of mammalian species recovery following the penultimate glaciation.

Getting stuck in...

I commenced an excavation of the site in late January 2009, originally intending to excavate two 1x1 metre grid squares. Excavation was conducted in 5cm intervals, following the boundaries of the six hypothesised layers. By early March, I was only half way through the first grid square. Digging was slow given that the sediment was sticky, clogging up brushes and limiting the primary excavation tool to a dental pick. On the positive side, I felt (for the most part) confident that was taking care with the fossil material and following the stratigraphy as accurately as possible. I decided then however that I would only excavate one grid square. The yield of material from the portion I had already excavated justified this decision. At completion, the grid square contained a total of just over 4500 identifiable small mammal specimens!

By the end of April I celebrated finishing the first stage of my project, the excavation. By this stage I had also prepared and analysed 44 tooth enamel samples with Dr Linda Ayliffe at the Australian National University in Canberra and was almost on top of the sorting. I would not have been able to achieve so much over those first few months without the support of the guys from the Palaeo society, Nathan Jankowski from the University of Wollongong, my family and of course, my supervisors.

At the start of May I made the move back to Adelaide and settled into the Palaeontology lab which I was lucky enough to have to myself. This meant that I could spread out the boxes of Grant Hall fossil specimens, comparative material and reference books that were my bible's over the next couple of months. My first goal was to identify all the small mammal material, as mentioned, over 4500 specimens worth. I was encouraged by Alex Baynes and Matt McDowell that achieving such a feat was completely possible. And with their support, and that of Graham Medlin and David Stemmer of the South Australian Museum, I looked at every single specimen and, with few exceptions, identified them down to species level. Surprisingly, I found the larger material more challenging and am very grateful to Gavin Prideaux for taking the time to identify them with me.

Over this period I broke up the monotony of the identifications by working on my sediment analyses under the support and guidance of Dr Erick Bestland from Earth Sciences. Having no geology background, this aspect of my project was the most challenging for me, drawing on techniques, analyses and terminology that I had not encountered before. For this reason, completing the sediment analysis was very satisfying and it was exciting to be able to compare the Grant Hall sediments with other cave fills from the Naracoorte Caves, as well as regional soils including Murray Darling Silts and Terra Rossa Soils.

Getting results and piecing it all together...

Geochronology

It was not until early August that I received the OSL ages from Nathan. I had been waiting with bated breath, given the importance of defining the temporal and environmental context in which the fossil material accumulated. And the chronology provided was interesting to say the least. It showed that accumulation occurred more recently than previously hypothesised; sediments accumulated between approximately 86,000 and 72,000 years ago.

Rather than coinciding with the peak of the last interglacial, this chronology places the Grant Hall deposit at the end of the interglacial cycle, when conditions were not as warm and moisture availability was much higher (Ayliffe et al., 1998). Regional pollen records indicate the presence of open woodland with a well developed understorey at this time (Cook, 2009). What is also interesting about the new Grant Hall chronology is that it places

accumulation of the uppermost layers at the transition from interglacial to the following glacial conditions. Conditions became much cooler and drier over this interval (Ayliffe et al., 1998), resulting in the expansion of heath and mallee vegetation communities in the region (Harle, 1997).

Sediments and Stratigraphy
Grain size and geochemical analysis of the Grant Hall sediments indicated that they are not strictly homogeneous across the stratigraphic profile, reflecting variation in transport, accumulation and post depositional processes over the history of accumulation. Mudflow is expected to have been the primary mode of accumulation for the site given the lack of fine stratigraphy and poor sorting of different grain and gravel size classes in the sediments. However, aeolian deposition may have contributed to the accumulation of the uppermost layer given it's unique geochemistry. In fact, the Grant Hall sediments as a whole are unique from the other Naracoorte Cave fills but share similarities with sediments from the Bool Lagoon lunettes and Terra Rossa Soils from local quarries.

The designation of six sedimentary layers at the start of the project was refined to five units, labelled as unit E at the bottom to unit A at the top.

Faunal Record
Analysis of the fauna involved determining the taphonomic biases associated with the deposit and how these impact the ecological interpretations. The quantity of small mammal material relative to the large mammals indicated a clear accumulation bias towards small mammals. As the entrance to the cave is now closed and little is currently known about it's geological context, this bias may have resulted from the contribution of pellet material by owls. However, it is also important to consider that the apparent bias may reflect the true abundance of small mammals in the ecological community relative to large mammals. Importantly, specimen density graphs indicated that taphonomic biases are likely to have impact both size classes in similar ways and are therefore unlikely to distort the ecological interpretations of the faunal analysis.

A total of 47 mammal species from 14 families were identified for the Grant Hall deposit. Examination of species richness within each of the depositional units showed that, if sample size is controlled, there is no major variation in species richness values between units E to B. This is important as it shows that there was no major diversification or influx of species to the region, nor was there any great extinction event.

When it came to examining the relative abundance trends of the Grant Hall fauna,
I noticed that there were five basic patterns that were being repeated by the different species. Some species declined in relative abundance, while others increased over the same depositional interval. Others showed progressive patterns of decline over the entire deposit, while some had more dynamic responses of increase and decline. In order to interpret these patterns, I compiled the known ecological preferences for all the Grant Hall species and compared them between individual species and the different relative abundance trends. While certainly not always clear cut, there appeared to be a general pattern of decline in the relative abundance of dense woodland inhabiting species while those that show a preference for open heath tended to increase. In the context of the temporal and environmental history of the site, there is suggestion of a correlation between shifts in the relative abundance of the fauna and changing climatic conditions from warm-wet to cool-dry conditions.


Centrum from vertebrae of Palorchestes azael

Having identified this correlation, I then sought to make comparisons of the Grant Hall fauna with other Naracoorte fossil sites. A stand out feature of the fauna from this deposit is the very low abundance of Grey Kangaroos. In other deposits such as the Fossil Chambers of Victoria Fossil Cave and Cathedral Cave, greys are the most abundant large Macropods. In Grant Hall, the smaller wallabies, Red-necked and Swamp Wallaby are more abundant. This may indicate that environmental conditions over the accumulation of Grant Hall were not suitable for Grey Kangaroos. This question definitely deserves greater investigation.

Emergence of long term trend...
In his analysis of the Cathedral Cave fauna, Gavin Prideaux also plotted relative abundance trends for a range of species (Prideaux et al., 2007). This provided me with an opportunity to directly compare species patterns between the two deposits. What emerged was the first evidence of a comparable ecological response to shifting climatic conditions in the longer term; the relative abundance trends of the Grant Hall fauna are consistent with the trends observed in the Cathedral Cave deposit.

This is highly significant as it represents a level of 'repeatability' of the impacts of environmental and climatic change on the local ecological community. They also

indicate that the regional faunal community was resilient in the long term to climatic fluctuations between cool, dry and warm, wet conditions that characterised Quaternary climates. While this finding has important implications regarding the extinction of the megafauna, these deposits also indicate that a number of smaller mammal species moved away from the region or became locally extinct over the Late Pleistocene – Holocene transition, from 20 to 10 thousand years ago. These trends raise important ecological questions relating to the relative influence of climate, biological interactions, human activity and individual species responses in the emergence of the 'modern' faunal assemblage, and the direction of change we may expect in the future.

Where to from here?

Many times during the year I was asked what I planned to do when I finished my Honours. I found this question a difficult one, if not also slightly annoying; in my mind I was opening doors for myself in terms of my career, I just didn't have expectations on what doors they might be. By the time I was well and truly into writing my thesis, one of my supervisors sat down with me and asked me the same question. Without hesitation I answered: apply to do my PhD. Working on my honours research was immensely satisfying and I was actually having fun. The results were intriguing, I could see potential for asking more questions, and I was surrounded by an incredibly supportive group of academics, students and friends. So, in March I will start my PhD research into the long term ecological trends recorded in the Naracoorte fossil deposits, and I can't wait...

Thanks to everyone who provided support and advice over my Honours year and for all your encouragement in my application to undertake my PhD. It has made a huge impact on me and given me so much confidence to keep going.

Amy Macken

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James and Carey sorting Grant Hall material...

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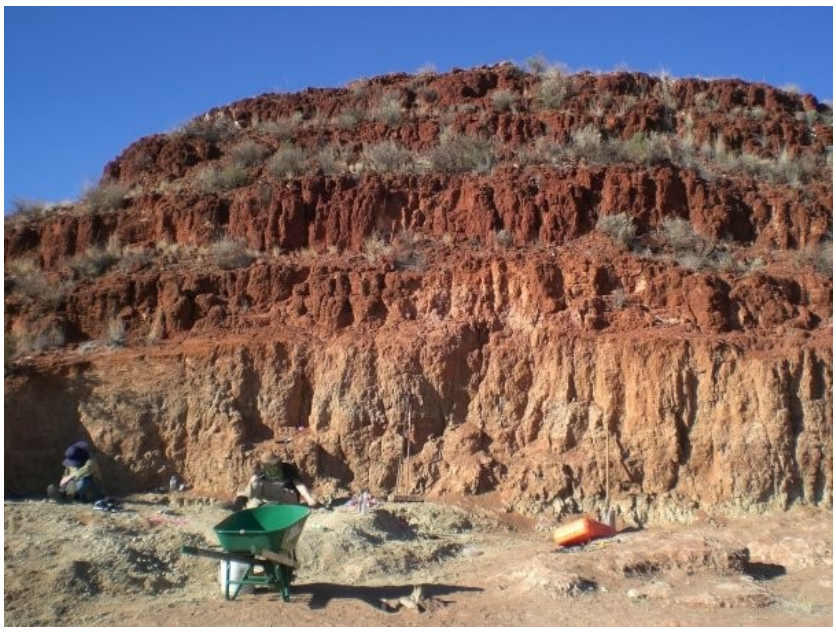
ALCOOTA WRAP-UP

In late July, a small number of Society members ventured North (North-East for some) to the Alcoota Fossil Beds approximately 200km NE of Alice Springs in the Northern Territory. This open site bears two assemblages within the Waite Formation across three pits; the Alcoota Local Fauna (LF) found in Main and South Pit, and the Ongeva LF in South Pit (Hill I). While the ages are uncertain, biocorrelation suggests the assemblages date in the Late Miocene (11.5 – 5.3 ma) to Early Pliocene (5.3 – 3.6 ma), with the Ongeva assemblage the younger of the two. While the WA contingent that was Aidan Couzans and Caitlin Syme took

to the air, Gav, Gus and I hit the road. Our first stop in the two day journey to the Alice was the mining town Coober Pedy, famous for it's opalised fossils. While there is no fossicking to report, Radeka's Underground Backpackers put the beer in "BEER'N'BONES". Despite Gav and Gus retiring early after the long day of driving, your intrepid reporter took it upon himself to do the required research while watching the Ashes in the small bar next to reception. All premixed spirits (if that's your thing) were priced at $7 and beer at $6 per stubby. Despite being in the middle of SA's arid heart, we weren't to go thirsty with a respectable range which included most of the Cooper's range (including the 2008 Vintage Ale, your reporter's personal choice), Matilda Bay's Beez Neez and Blue Tongue Premium lager were among other more pedestrian brews.

After refuelling and a quick check of the oil, we were off again in the morning headed for Alice Springs to pick up the arrivals from WA and bed down at the Araluen Cultural Precinct (which houses the local art and entertainment centre, and the Museum of Central Australia). The cottage accommodation was organised for the Society courtesy of Dirk Megirian, former curator of geology and palaeontology at the MCA.

As some of you may have heard from Bear Grylls, when heading into isolated arid areas it is important to take plenty of fluids and remain hydrated. With this in mind we made a stop at the bottle shop before refuelling and setting out to Alcoota. Aidan and I shared a carton of Cooper's Best Extra, while Caitlin picked up some cider. Gavin opted for the light option in the Cooper's range and some wine.



Caitlin and James in South Quarry Hill I (Cowpat Hill). Photo by C. Syme

After briefly losing a swag at Gem Tree, we arrived at the scientific reserve in time to see Peter Murray presented with a bronze cast of a *Kolopsis* skull, a token for his recent retirement from Assistant Director at the Museum of Central Australia. After meeting the team, we were given a brief tour of the site by Jared Archibald before setting up our tents. Our first day of digging was spent in South Pit (Hill I), better known as Cowpat Hill. Despite an apparent dearth of fossils, the site lived up to its reputation as one of the most difficult to excavate when it yielded some finds. The contraction and expansion of the clay soils over the millennia has rendered the fossils into many small pieces. While all the necessary pieces are in association, making it possible for whole skulls to recovered, care (and a gallon of glue) is required to extract the fossils keeping the pieces in place.

With a thirst for experience and a hunger for fossils, Aiden, Caitlin and I later made a move to Main Pit while Gavin and Gus remained on Cowpat. Aiden set to work on cleaning and further exposing a Dromornithid pelvis and Caitlin worked on a small collection of bones, revealing some large Crocodilian osteoderms. I was given the goal of excavating down and around a *Kolopsis* (some prefer *Collapsis* due to their tendency of, well, collapsing), which exposed more Diprotodontian fossils and perhaps something Avian. Gav and Gus continued with little success, finding a few smaller pieces, until proving on the last full day of digging that persistence is the key with the finding of some important Diprotodontid which may help us to get a better understanding of the antiquity of the site.

All too soon it was time to pack up and make the two and a half day journey back to Adelaide, or the short (in comparison) flight back to Perth. Alcoota presented some interesting challenges (mainly flies) and yielded some fascinating finds, and it is hoped the Society can make a return. Peter, Dirk, Jared, Gavin and Sam are thanked for their efforts in organising this trip for the Society.

Sadly on the 27th, just days after our departure from the site, Dirk passed away at Alcoota after a long battle with cancer. Australia lost a great scientist, and a large void is left in our field. On behalf of the Society, we send out condolences to his family and friends.

James Moore

Coprolite, with fresh cowpat for comparison, on cowpat hill. Scammed from Megirian, Murray and Wells 1996.


Jared and Aiden in Main Pit. Photo by C. Syme.

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INTERVIEW:
GILBERT PRICE

You have done a lot of work in Pleistocene deposits in Queensland. Can you just tell us a bit about the story that is emerging there?
Most of my work has been focused on the Darling Downs area itself, which is sort of in the south east corner of Queensland, just up on the other side of the range, so it's only a short drive from Brisbane itself. What's cool about the area is that it's a site that's been collected over the last 160 or 170 years as the old school explorers went through there, like Sir Thomas Mitchell and Ludwig Leichart, you know these old school blokes who were pulling fossils out of the creeks in abundance. Leichart even found these giant Diprotodon limb bones and he wrote in his diary at the time that he expected to come across the living animal further inland in his expedition, so it's quite amazing stuff. More recently work has been done by people like Alan Bartholomai, who was really instrumental working there in the 60's and 70's and did a lot of taxonomic work on the kangaroos especially. But my work is going a bit beyond that by looking at more palaeoecology, more total faunal stuff. Not just focussing on Kangaroos themselves, or even megafauna or whatever you want to call them but looking at whole faunal assemblages. So I'm trying to pull out everything from big mammals and lizards down to frogs, bandicoots and all those little critters.


Gilbert in the field.

You talk about palaeontology and palaeoecology being of use to modern ecology. What is it in particular that palaeontology offers modern ecology?
This is one thing that I think about all the time, and I always think about what the real value of palaeontology to society is, and for me it's understanding how populations change and respond to various environmental changes or climatic change or whatever sort of impacts there were in the past. We look at modern communities today and modern conservation strategies, and one of the big questions that we are trying to figure out is what is going to happen to these populations in the face of things like climate change and habitat loss, and all this sort of stuff in the future. I guess the strategy is to go out and sample a modern population of a kangaroo or a bandicoot or whatever you want, but the problem is the temporal period of sampling. We might have data on how a population might respond to really short term impacts. For instance we might be able to monitor a modern population over a season or if you're lucky a few seasons or a few years but we just don't have that long term information about how these populations may respond over a greater period of time, beyond the five years or the ten years or even the 50 years, and I think that is what the real value of palaeontology is. Looking at the past, identifying the deposits that span long periods of time, identifying species that are still around today, so extant species that have fossil records, and looking at what happens to them. I think it's so cool and there is so much information in the record and the rocks.

Do you think it can at all work the other way? Are there factors in ecology that can help us better interpret fossil communities?
I think it works both ways. You need to have some sort of broad understanding of modern ecology to be able to interpret palaeoecology, but there are also things that we can learn from palaeoecology too that we can apply to what we do today, and so it does work both ways.

During science week, you said that that part of this understanding means to move from the traditional 'science geek' approach to palaeo. What do you mean by this?
It's like I was saying earlier about looking at the value of palaeontology to society today. I go to these bloody conferences and I see these guys get up and they talk about their fossil and

they can tell you everything about their little tooth or bone. They talk about all the ridges, the cusps, the sharp and pointy edges and they might be able to tell you how it fits in to some phylogeny or how it's taxonomically significant but most of them never really say why it is that they are important. Why do I need to know that? That's the big thing that I keep thinking. The most boring talks I have ever been to have been by palaeontologists. It's easy to get caught up in the science, because it is pretty interesting and cool stuff. I'd love to see more emphasis or focus on getting the information out there, and not just to the scientific community, but getting it out to everyone and telling everyone why it is important. I think that is the way we have to go, especially in palaeontology, which at times it's seen as a bit of almost a luxury science, I guess you could call it, but there is so much application for understanding the world around us today.

The impressive looking and sounding thermal ionization mass spectrometer used in radiometric dating.

But doesn't palaeoecology require much of this sort of this boring stuff like taxonomy to function?
Absolutely, But there's always something cool about the work, I mean for example just look at Gavin Prideaux's work on the Sthenurine kangaroos, I mean that guy spent a god awful amount of time working on his big monograph that came out a few years ago, but it's such a significant thing. As Gav will say, what's so clear in the work itself, what he's been able to show, is the number of species that have gone extinct in the past, and this is on the basis of taxonomy. Taxonomy itself is boring, but the implications of taxonomy isn't. So Gav is able to say we've got x number of Sthenurine kangaroos going extinct at this time, we've got these evolutionary events taking place through these periods of time, we've got x number going extinct at this time. That;s the really cool stuff. Some people are really able to get in there and pull the cool stuff out and really promote it, and I don't see why everyone can't do that with their own work.

You have also done a lot of work on the dating of deposits. Can you tell us why precise dating of deposits is important?
There are a lot of reasons why dating is important. Firstly, you want to understand rates of change within a single site. Say you've got a site that is 10 meters thick, and you've got various animals up and down through the deposit, and you want to understand the rates of change. You can look at things using stratigraphic superposition so you know what's older and what's younger but the radiometric or luminescence dating can tell you the rates of change through time. So not only do you have the local significance, but you also have the significance in placing that site, whatever site it is, into a bigger more regional, or even continental context, for understanding things like population changes, and how these particular sites might temporally correspond or maybe not correspond to significant climatic events that might be documented on the basis of other things like laucusterine (lake) deposits or speleothems or anything like that. Dating is everything. And there have been so many great techniques that have been developed over the last 20 years, especially for quaternary dating that there really is no excuse for everyone not getting into dating these days, since it is so important. The techniques are great, they're becoming more and more affordable, and they are being refined as well. So we are able to refine the dating methods, refine the error bars associated with dates. It's such a significant piece of quaternary science.

Dating though has traditionally been done by physicists or chemists, people working outside of palaeontology. What advantages does doing the dating yourself provide?

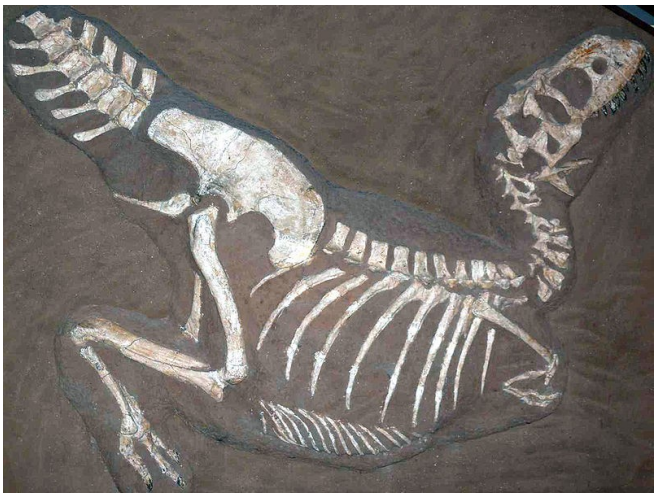
For me I have a massive advantage in that I am probably the only vertebrate palaeo person that I can think of in Australia that is specifically trained in radiometric dating. I've got the training in the bones, and now I have the training in the dating itself, and that is really good for a number of reasons. One, I can identify the right and best samples for the dating itself, and I have a really good understanding of how to interpret those dates. I am in a very luxurious position, there are lots of other people that are smarter than me that might just not have the opportunity to be able to work in a place like this, but there is no reason why people can't collaborate with the leading experts on the dating in those fields. So collaboration is just as important as the position that I might have myself.

Interview by Sam Arman

FEATURE FOSSIL 5
Tarbosaurous efremovi
Maleev, 1955

In this issue, we look at the Soviet Palaeontologist Ivan Efremov who took the maxim of 'understanding the past to understand the present' one step further.

One of the great things about palaeo is the ability to look at changes in intertwining phenomena over time. So we can look at continents moving over time, and see how that has impacted on climates, biota and all the feedback loops between them. Palaeo is also a science though, so any conclusions you make can only apply for the times for which you actually have empirical data. So while we can understand in great detail why we have the particular suite of animals we have now, we can say relatively little about what they may be a million years from now.
So how do we respond to that? Simply admit the limits of science, and run blindly into the future? Of course not. Often science can make some predictions about the future, but as any climate change sceptic (why it is that you were listening to them I am unsure) will tell you, it is notoriously difficult to predict anything in the future *with accuracy.* To draw long scale inferences, Ivan Antonovich Efremov (sometimes Yefremov) tried another tact, he added 'fiction' to his science and began to interpret a number of broad potential futures, to imagine just how life may end up in the long run.
Efremov wrote five novels in his lifetime as well as a number of short stories. His most famous however, *Andromeda: A Space Age Tale,* is the most famous. The story is a futuristic utopia set in a world where science and reason has given individuals the freedom to pursue whatever lifestyles they desire. All nations have been united under 'the mighty tree of communist society that flourished throughout the planet.' (Yefremov, 1957, p52), and ships operating at 99% the speed of light have allowed the exploration of the galaxy to begin. Much technology has also been gained by the Earth's admission into the 'Great Circle', a sort of intergalactic chat room. Efremovs scientific background emerges here, with detailed explanations of the basis for much of this technology, as well as its short-fallings, such as dealing with the effects of relativity during high speed travel. Earth has also been dramatically altered, with global high-speed public transport highway/railways, great canals, and twin equatorial farming bands, together with great seaweed farms providing sustenance for all humans. In a strange turn on global warming, artificial suns were placed over the poles, to intentionally melt them to warm the planet as well as open up larger seaways and tame storms.
Palaeontological work has also greatly benefited, with the advent of excavation machines, as well as the advent of depth photography, where mechanised 'moles' burying electron tubes, which effectively X-ray the Permian rocks. In this, Efremov also could not resist a five page description of the wonders of the technique and the imaged beast. The novel also tells much about the anthropocentric state of evolutionary theory of Efremov's time, describing a dance ' as though recalling the the great ladder of countless unnamed victims sacrificed to the development of life that had produced man, that beautiful and intelligent being.' (Yefremov, 1957, p64). It was also made into a 1967 film *The Andromeda Nebula; Episode 1, Prisoners of the Iron Star*, which was initially proposed to be the first in a series which never eventuated.
Efremov himself worked on a number of fields within palaeontology, principally on Permian rocks. He worked over much of Russia, in particular though he worked in Mongolia, and in an interesting political note followed the work of the Americans documented earlier in BEER'N'BONES (vol. 3 no. 2). His work though is largely unavailable in English, though a few of his works have been translated from Russian into German.
He established the field of taphonomy, the study of the processes that can affect an organism between the time that it dies, and is excavated (see BEER'N'BONES 3.2).
Eferemov was also heavily involved in the 'Moscow Group', which during world war II worked to pack and transport a huge collection of type and rare specimens to safer storage areas. During this time, one of his colleagues wrote, 'We are accustomed to air raids and bombing. If a night is spent without an alarm, it seems that something is missing.' (Bodylevskaya, 2007, p212). Efremov, with two other researchers spent many nights in the museum, sleeping between boxes to put out any fires that may threaten the collection. In deciding a storage facility, Efremov suggested the Kargalinskie Mines, due to their dryness, and constant temperature. His work in this regard made him one of the few researchers to be spared military service.
Tarbosaurous efremovi is a



A Tarbosaurous *specimen from a German museum.*

tyrannosaurid, discovered in the Mongolian Palaeontological Expedition of Sciences USSR in 1948-49 from a site initially worked on by Efremov. *Tarbosaurous* translates as 'Terror Lizard' in fitting with the general alarmist names given to dinosaurs at the time. It is distinguished from other similar tyrannosaurids by its size, its elongated skull, and lack of bony protuberances found in the related species *Gorgosaurous.* Originally the type of the genus, the previously named *Tyrannosaurus bataar* was later realised to represent a *Tarbosaurous* and is now considered the type of the genera.

T. eferemovi is considered one of the largest tyrannosaurs, at approximately 12-15m in length and standing 5m tall. It possesses 16 upper and 15 lower teeth, which are described as sabre like and marginally serrated. It also possesses short forelimbs, and a powerful foot 'suggesting an enormous pressing iron in shape.' (Maleev, 1955, p780). Like many dinosaurs, *T. efremov* also had a small brain of ~180-200cc, (you, dear reader have an average brain size of 1130cc, or 1260cc if you wear a dress). In form, it is generally similar to other tyrannosaurids, and virtually indistinguishable in form from the 'humblest of all God's creatures, *Tyrannosaurous rex*' (Bender's Game, 2008), which was slightly larger. They had strong olfactory bulbs, and acute binocular vision to assist them in tracking and capturing prey. His name is also engraved in space, with a main belt asteroid being named 2269 Efremiana after him in 1976.

Reconstruction of T. efremovi

Sam Arman

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And finally..

The ganglion on the pelvises of some dinosaurs was so large (relative to their brain), they have been said (loosely) to have two brains, inspiring this little poem...

The Riddle of the Dinosaur
Bert Leston Taylor

Behold the mighty dinosaur,
Famous in prehistoric lore,
Not only for his power and strength
But for his intellectual length.
You will observe by these remains
The creature had two sets of brains -
One in his head (the usual place),
The other at his spinal base,
Thus he could reason *A priori*
As well as *A posteriori*.
No problem bothered him a bit
He made both head and tail of it.
So wise was he, so wise and solemn,
Each thought filled just a spinal column.
If one brain found the pressure strong
It passed a few ideas along.
It something slipped the forward mind
'Twas rescued by the one behind.
And if in error he was caught
He had a saving afterthought.
As he thought twice before he spoke
He had no judgment to revoke.
Thus he could think without congestion
Upon both sides of every question.
Oh, gaze upon this model beast,
Defunct ten million years at least.

Unearthed by James Moore

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