ANNUAL REPORT

Field Report by Lesley Kool:

This year is one of great significance in Australian palaeontology as it is exactly 100 years since the discovery of the very first Australian dinosaur bone. On May 7th 1903 William Hamilton Ferguson, a field geologist with the Victorian Geological Survey, noticed a small fossil bone exposed in the rocky shore platform at Eagle's Nest, near Inverloch, Victoria. This small fossil turned out to be a dinosaur claw and the eventual catalyst for the discovery of hundreds of dinosaur bones in the last 25 years.

William Ferguson's story is told in more detail by Danielle Shean, a Science student at Monash University, who took on the task of history detective to track down Ferguson's descendants and decipher his note book. Her report makes fascinating reading.

The centennial of the discovery of the first Australian dinosaur bone on May 7th 2003 was celebrated with a gathering of researchers, sponsors, locals and media at Eagle's Nest. A number of William Ferguson's descendants also attended and Tom Rich gave a stirring speech at the very spot where, one hundred years earlier, Ferguson found the dinosaur claw.

To coincide with the 100th anniversary Dr. Tom Rich and Professor Patricia Vickers-Rich, co-head researchers of the Dinosaur Dreaming Project, have published a book, with The Queen Victoria Museum, recounting dinosaur discoveries in Australia since 1903. Aptly named "A Century of Australian Dinosaurs" the book is a chronology of significant Mesozoic fossil discoveries from a rather shaky start to a philosophical discussion on the hard work and persistence that lies ahead. Anyone wishing to purchase a copy should contact the Monash Science Centre, Monash University, Melbourne, 3800.

The Dinosaur Dreaming 2003 field season commenced on another special day on the Australian Calendar – 26th January – Australia Day. This year was our 10th field season at the Flat Rocks site near Inverloch, which marked another milestone for the project. The excavation was in the same part of the fossil layer as the previous two field seasons, adjacent to the area where the two *Bishops whitmorei* jaws were recovered in December 2000. The chart below lists all the mammal jaws that have been recovered so far, 23 in all, and the years they were found. The year that stands out as the most prolific is 2000. During the Dinosaur Dreaming 2000 field season we recovered four mammal jaws among a total of 986 catalogued bones and teeth. Then in December 2000 we held a one-day dig at the Flat Rocks site as part of the volunteers training program, which we conduct prior to each field season. On that day we sampled a small part of the fossil layer that we had not previously excavated, which was located conveniently close to the surface of the shore platform. In the small quantity of rock that was excavated that day three mammal jaws were found. Two were from a previously unknown genus and species of tribosphenic mammal, later described as *Bishops whitmorei*. The third was a partial mammal jaw with no teeth preserved. The discovery of these jaws in such a small rock sample prompted Tom

Rich to redirect our efforts to this part of the fossil layer. For the next three field seasons we excavated this part of the fossil layer, which appeared to represent the edge of the river channel where small bones were concentrated, resulting in the discovery of seven more mammal jaws.

Five of the mammal jaws from the three field seasons have been attributed to the family Ausktribosphenidae. The remaining two jaws belong to the micro-monotreme *Teinolophos trusleri*. One of these jaws is of particular interest to Tom Rich because although it is edentulous (having no teeth preserved in the jaw) it does possess structures on the back of the jaw that are not preserved or are indistinct on the holotype of *T. trusleri*. Tom discusses this jaw in his report below. This jaw was discovered during the 2002 field season, but was not recognised as a mammal at the time. Not until November 2002 was it finally examined under a microscope and initial preparation revealed it to be an edentulous mammal jaw. This is a good example of the time-lag between the discovery of a specimen and its ultimate preparation and recognition. Each field season an average of 1000 fossil bones and teeth are recovered and catalogued, but the actual preparation of these specimens is far more time consuming, often resulting in months or years lapsing before their preparation.

At the end of this field season it became obvious to Doris Seegets and Nick van Klaveren that the fossil layer was thinning out in this area. After carefully mapping the excavation and producing a series of stratigraphic columns we decided to discontinue excavations on this part of the fossil layer and possible return to an area where mammal jaws had been found in previous years. A quick calculation of where and when mammal jaws had been found in the fossil layer demonstrated that at least one mammal jaw had been recovered during each field season and even before we began excavating in 1994. The holotype of *Teinolophos trusleri* had been collected during a Museum Victoria Mentor field trip in November 1993, but had not been identified as a mammal jaw because of it’s obscured cross-section. It had merely been noted as a small, interesting cross-section of bone and had been stored along with 20 or so other bones, collected on that day, for future preparation. That preparation did not occur until 1998 when all unprepared specimens were checked following the discovery of *Ausktribosphenos nyktos*, the “first mammal jaw” to be recognised in March 1997. On closer inspection this interesting cross-section revealed a single tooth in the back part of a lower jaw, which was quite unlike the tribosphenic teeth of *A. nyktos*. Unfortunately, the specimen had been badly damaged during excavation and parts of the back of the jaw were rather indistinct. This is why the latest *T. trusleri* jaw, despite its lack of teeth preserved in situ, will add a great deal to the evolution of this primitive group of mammals.

Two more mammal jaws were collected during the Dinosaur Dreaming 2003 field season. One was identified the day after it was discovered and Wendy White has written an entertaining account of how she became a member of the very exclusive club of mammal jaw finders. All discoverers of mammal jaws are presented with silver mammal jaw pins in appreciation of their achievement and Wendy was given her pin at the dig party near the end of the field season.

The second mammal jaw was not identified immediately as it had broken through the back of the jaw and was just labelled as “Caroline’s tiny curved cross-section”. However, all bones are checked under a microscope after the field season has ended and that was how the second jaw was identified. Caroline Ennis has been a regular member of the Dinosaur Dreaming field crew for many years but up until this year had never found a mammal jaw. So it was a very pleasurable experience to inform Caroline that one of her many discoveries had turned into a mammal jaw.

This field season we were pleased to host a visit from a group of Japanese researchers who were interested in the way we train our volunteers and conduct our dig. The group of seven Japanese Dreamers was led by Dr.Yoshitaka Yabumoto from Kitakyushu Museum, who specialises in the study of Mesozoic fish and has visited the site once before. Dr Yabumoto's daughter, Mai, also accompanied him on her first visit to Australia. The group also included Mr. Kenji Baba, an amateur palaeontologist who had worked at a similar site in Japan and was interested in how we trained our volunteers. Keiichi Aotsuka, a palaeontology student making his first trip to Australia, found a very nice turtle vertebra, which has since been prepared. Dr --- was accompanied by her young daughter – who quickly became the centre of attention with the Australian crew. Although the group was only with us for three days the interaction between the two groups of dreamers was outstanding. They enjoyed a roast lamb dinner on their first evening, followed by a spirited game of croquet against the Australian crew.

Three additional Japanese Dreamers were able to spend a longer period with us during the dig. Two students of Dr. Makoto Manabe, a colleague of Tom Rich and Patricia Vickers-Rich, were able to join us for an extended time. Ryoko Matsumoto had visited the site previously with Dr. Yabumoto and was heartily welcomed back for her second visit. Tomoyuki Ohashi has just finished his Masters Degree on hypsilophodontid dinosaurs, so his knowledge of this particular group of dinosaurs common to both Australia and Japan was very much appreciated. Chisako Sakata had worked at a dinosaur exhibition in Dr. Makoto's museum in Tokyo and had heard of the dig from him. Her enthusiasm and sense of humour quickly made her a favourite with the crew.

We were also delighted to see the return of Raul Vacca, a preparator from Patagonia who was in Australia to mount the cast of *Cryolophosaurus*, a theropod dinosaur from Antarctica. Raul is a world expert in mounting dinosaur skeletons and was invited to the Monash Science Centre to ready this exciting skeleton for exhibition in Japan. Fortunately for us he had time to spend a couple of weeks at the dig, which is a very different environment to the fieldwork in his native Patagonia.

The second day of their visit coincided with the annual "Friends of Dinosaur Dreaming Day" when current Friends are invited to visit the site and are given conducted tours of the excavations and surrounding area. Our Japanese friends were put through the training program so they could recognise the fossil bones in the rocks and then they were put to work to find their own fossils. The highlight of the day was the discovery of a superb plesiosaur tooth, found by Dale Sanderson. Measuring 5cm in length, it is the largest plesiosaur tooth that has been found in the Strzelecki group so far.

Friends Day was a great success, as usual, with almost one hundred "Friends" visiting the site and it was a great opportunity for our Japanese dreamers to experience the support received for the project by so many enthusiastic people. We celebrated the day with a traditional Aussie barbecue, complete with pavlova, which was enjoyed by all and although our new "friends" were only with us for such a short period of time, good friendships were made, which I am sure will endure. One of the Australian crew, Gabrielle Metherall, has already benefited from the exchange when she visited Japan shortly after the dig ended and was invited to join a Japanese dinosaur dig at Shiramine.

As well as the mammal jaw recovered this field season a number of other significant finds were made, including four small hypsilophodontid dentaries or lower jaws. Three of the jaws had only one tooth preserved, all in the same position in the jaw. They are all approximately the same size, about 4cm long and are quite gracile, not robust like *Qantassaurus intrepidus*.

Five more theropod dinosaur teeth were also recovered this field season, bringing the total collected from this site to over 70 specimens. During Tom Rich's recent trip to the United States he spent some time studying the subtle differences in small theropod teeth in American collections and intends to apply that knowledge to our theropod teeth. Preliminary studies of almost 40 of our theropod teeth by Dr. Phil Currie of the Royal Tyrrell Museum of Paleontology in Drumheller, Canada, suggests we have at least four taxa of small theropod dinosaurs, so Tom will use these results as a basis for his research. He may also be able to solve the mystery of a group of teeth we have been calling "pterosaur" teeth. These small bilaterally compressed teeth are an enigma and have been tentatively assigned as pterosaur teeth by a process of elimination. The identification of what we think are pterosaur limb bones has supported this identification, and it is hoped that Tom will be able to resolve the dilemma.

A single ankylosaur tooth was also recovered, which are quite rare in this fauna. Although we find hundreds of dermal ossicles, which were embedded in the skin of these small armoured dinosaurs, we have only collected a scant half dozen teeth, so any addition to them is welcome. Most of the ankylosaur teeth collected so far are very similar to those of *Minmi paravertebrata* from Queensland, however, one specimen appears to have a divided root. Russian palaeontologist, Dr. Tatyana Tomanova from the Paleontological Institute, Russian Academy of Sciences, Moscow, who specialises in the study of ankylosaurs, will be visiting Australia later this year and we look forward to her comments on our collection. Matthew Inglis also completed a 3rd year project examining these teeth.

A number of small gracile bones were found and preliminary studies by Professor Pat Vickers-Rich suggest that one specimen may be a bird humerus and another partial limb could be a pterosaur tibia. Studies with Roger Close, a 3rd year Science student, of the bird furcula ("wishbone") found during a previous field season, suggest affinities with enantiornithines, a common group of birds in the Cretaceous. The bones of birds and pterosaurs are rare in the fossil record as they are thin walled and hollow and so do not preserve well. Many small hollow limb bones are found in the Flat Rocks fossil layer, but most of them consist of just shafts, with no ends, and therefore are almost impossible to identify.

Many fossil bones that have been collected from the Flat Rocks site over the last ten years have been prepared and some have been cast and are part of a display in the travelling exhibition that is in the Fukui Protectural Dinosaur Museum in Japan. As in previous years, Qantas Airlines generously transported the exhibition, which is why it has a dinosaur (*Qantassaurus intrepidus*) named in its honour.

Larger than usual crews resulted in the need for more rock than could be removed from the main excavation, so easily accessible rock was taken from the area we call “The Bridge Area”. This area represents the most seaward extension of the fossil layer (see Map 4, sections 4 & 5) and is exposed on three sides, allowing for quick removal of the fossiliferous rock. A number of fossil bones and teeth were recovered from this part of the fossil layer, including evidence of turtles, fish and dinosaurs.

Dinosaur Dreaming 2004

Nick has selected two possible areas for excavation during the next field season. Area 1 on map 2 is adjacent to the area we excavated in the 2000 field season. It was to be the logical area to continue in 2001 until the two mammal jaws turned up in December 2000, which prompted us to change our plans. Area 1 actually overlaps the excavations of the 2000 field season, allowing us to continue sampling the part of the fossil layer that produced four mammal jaws. If there is a concentration of mammal material anywhere in this fossil layer, this is the most likely area.

LOCATION OF MAMMAL JAWS FROM FLAT ROCKS SITE, THE CAVES, INVERLOCH, VICTORIA

No.	Museum Cat. No.	Year discovered
1*	P209090	1997 (#1111 N. Barton) (*Ausktribosphenos nyktos*)
2*	P208228	1995 (#329)(Ausktribosphenos sp.)
3*	P208230	1994 (#560)
4*	P208231	Nov.1993 (Mentor's trip) (*Teinolophos trusleri*)
5*	P208482	1999 (#150 N. Gardiner) found in rock from DD1998
6*	P208483	1999(#140 N. van Klaveren)
7*	P208484	1999 (#450 K. Bacheller) (*Bishops whitmorei*)
8*	P208526	1994 (#560) (*Teinolophos trusleri*)
9	P208580	2000 (#200 A. Maguire)
10*	P208582	2000 (#500 L. Irvine)
11*	P209975	2000 (#387 R. Close?)
12*	P210030	2000 (*Teinolophos trusleri*)
13*	P210070	2000 (Rookies Day 3.12.00) (*Bishops whitmorei*)
14*	P210075	2000 (Rookies Day 3.12.00) (*Bishops whitmorei*)
15	P210086	2001 (#250 J.Wilkins)
16*	P210087	2001 (#620 G.Kool) – undescribed
17	P212785	2000 (Rookies Day 3.12.00 M.Anderson) – fragment only
18*	P212810	2002 (#300) (*Bishops whitmorei*)
19*	P212811	2002 (#187 D. Sanderson) (*Teinolophos trusleri*)
20	P212925	1996 (#222) prepped by D.Pickering
21	P212933	2001 (#179) (*Teinolophos trusleri*) plus associated tooth
22	P212940	2003 (#171 W.White) (*Ausktribosphenos nyktos*)
23	P212950	2003 (#292 C. Ennis) (*Bishops whitmorei*)

* indicates jaws that have been moulded and cast as of June 2003

YEAR	NUMBER
1993	1
1994	2
1995	1
1996	1
1997	1
1998	1
1999	2
2000	7 (3 0n Rookies Day 3.12.00)
2001	3
2002	2
2003	2
TOTAL	23

<u>Excavation Report by Nicholas Van Klaveren:</u>

The Flat Rocks fossil locality was excavated for a period of six weeks, from late January to early March 2003. This period was chosen to coincide with the university holidays and to avoid the tourist season at Inverloch.

All the fossil material was collected under permit number 10002039 of the Department of Natural Resources and Environment Victoria.
The excavation this year continued at the same location as last year because of the number of mammal jaws found previously in this part of the channel, with a further two more added this year.

Excavation Methods

The excavation method this year continued with the use of large iron wedges and sledge hammers to remove the bulk of the fossil layer from the targeted areas. Exposed specimens were removed with a diamond saw blade equipped Stihl TS460 Cutquik. The technique of removal used last year was continued with wedges driven into the semi-continuous coal layer at the base of Middle Sandstone Unit, then a second level extracted with the wedges driven into the Lower Sandstone Unit.

The unfossiliferous sandstone overburden was removed with the two Cobra petrol driven jackhammers, donated to us by Atlas Copco. Once the majority of the overburden was removed the method was then switched to sledge hammers and wedges so as to provide greater control to protect the underlying fossil layer from damage.

This year's excavation straddled a series of sand bars which had the appearance of massive clean sand lenses. The large chisels were driven into these if no continuous coal seams were available.

The lenses were, however, very hard and this required more sledge hammering and the use of on some occasions of all of the large wedges simultaneously.

The seaward (eastern) edge of this years excavation was bounded by the large fault at 188 mE and the blade of conglomerate between the point bars (see map 4, section 3) and the fault proved to be the richest in large bones. The rock next to the fault needed both chisels wedged down vertically as well as from beneath.

The excavation method at the "Bridge Area" (Map 1, Area B) consisted of the large steel wedges driven down vertically into the prominent joints and horizontally into laminated coaly layers at the top of the conglomerates. The hardness of the sandstone overburden here necessitated the resharpening of the large chisels. The fossil units here were removed by driving the large wedges into the basal contact between the Lower Conglomerate Unit and the mudstone. The units at the bridge area are more homogenous and being exposed on three sides, easily removed. This area represents the most seaward extension of the fossil layer (see Map 4, sections 4 & 5)

Equipment

The Flat Rocks fossil locality due to its location at the bottom of a cliff in the inter tidal zone facing Bass Strait presents a number of difficulties with regard to the difference in elevation and large waves at high tide.

In previous years, a construction consisting of packing material, plastic tarpaulins, steel mesh and rock bolted down iron beams was built to help exclude sand and thereby increase access time to the fossiliferous units.

Construction

This year's new version of the construction consisted of steel beams and mesh above and below the heavy truck tarpaulin. Lighter tarpaulins were enveloped over the lower mesh to help exclude the sand.

Having steel beams below the mesh removed the necessity of plastic drums, which originally were employed to exclude sand by physically taking up space. With improved sand exclusion the beams acted as an uplift force to press the tarpaulins against the overlying mesh and girders forming a tighter seal.

A new aspect of this year's version involved wooden beams slotted into grooves cut into the rock. The beams (splines) pressed the truck tarpaulin into these grooves helping to exclude the input of sand. Sandbags were used along the edges not secured by the wooden splines.

Major failings of this year's system were the need for a pin at the centre (which proved to be unnecessary) and the use of sandbags, which pose a lifting hazard. The overall height of the construction above the shore platform is limited by the use of the overlying girders to hold the splines in place. This was especially a problem this year as the quiescent weather led to record amounts of sand upon the shore platform.

Sump Pump

The sump pump and solar power unit worked well this year, but was found to have a failing in that it needed to have at least 5 cm of water depth to operate in as the water intake is mounted at this height.

This necessitated the construction of small square pits, which acted as sumps that had to be cut into underling fossil units. A new practice was evolved this year in which some of the power cells were shut off to reduce the pumping rate to that of the inflow of water removing the need to constantly turn off and on the pump.

A future version is envisaged to have an elbow extending downwards, a t-piece and a tap so that water may be drawn either through the present filter housing or a small pipe, millimetres above the rock surface.

Excavation Areas

Examination of Map 1 shows the two areas of excavation this year with Area A being the main area where the construction was built and Area B where small amounts of poorly fossiliferous conglomerate. Area B was excavated to provide extra rock at times of low production from the main area.

Area A
The main excavation area was troubled by problems this year in that it straddled a set of sandbars that were poorly fossiliferous. The construction was also built 30 cm to the south to allow the centre pin to be located at the northern edge of last year's excavation. This was so that it would not need to be overmined or drilled into prime fossil rock. A third factor was that some of the top most units had already been excavated in the previous season and due to the thinness (compare sections 1&2 versus 3 in Map 4) contributed to reduced volumes of prime fossil rock. This necessitated the excavation of the poorer thin Lower Conglomerate Unit in the floor, which proved to be very patchy in bones.

Despite these factors large numbers of small bones were found which may yet yield a few more mammal jaws after closer examination. The richest unit appeared to be the top contact of the middle conglomerate (Map 4, MCG 1) and the thicker conglomerate bound by the seaward edge and the sand lens (Map 4, Section 3, MCG).

Area B
Known as the "Bridge Area" as the overlying sandstone forms a barrier between the older most seaward excavated area at (100 mN, 200 mE) and a rock pool at (97 mN, 205 mE).

This area represents the most seaward extension of the fossil units which rapidly thin (see Map 4, sections 4 & 5) and are truncated by an overlying north-south sandstone lens at (95mN, 205mE).

The thicker lowermost units of the western part of these units proved to be the richest and the eastern and upper units being extremely poor in specimens.

Future Plans
The system in its present form allows any area to be chosen as next year's excavation area and is only limited by the length of the threaded rock anchors and the depth of sand upon the shore platform.

The choice of future excavation areas may be augmented by a study of the locations of each mammal jaw and from this the construction of a histogram with one axis being the strike across the excavation and the other axis the number of jaws found so far.
The areas 1 and 2 on Map 2, show two possible choices based upon ease of access (Area 1) and greatest overall thickness of conglomerate units (Area 2).

Palynology at the Flat Rocks Site
Doris Seegets-Villiers

To get a better picture of the environmental settings at the Flat Rocks fossil site an attempt was made, a few years ago, to establish the spore /pollen floral list for some of the sedimentary units at the site. First, a few spot samples from claystones were taken to see if the exercise was going to be worthwhile pursuing. The claystones were chosen because of their very fine grain size and thus their probability of microfossil preservation. Since spore and pollen grains are themselves very small (the ones that are dealt with in our Cretaceous sediments are roughly between 20 and 120μm) they are more likely to be preserved in sediments of similar grain size rather than in coarser sediments (such as sandstones) where they could easily get washed out. A similarity of grain size between sediments and spore/pollen does, however, does not necessarily mean that there are any spore/pollen to be found in the sediments, hence the spot samples were taken first and investigated. As it turned out all samples were rich in spore/pollen grains. It was, therefore, decided to take further samples. This time, they were taken from within and around two periglacial structures (these are features that are associated with seasonal freezing and thawing of soils). Again, claystones and where possible, organic bands were preferred. The purpose of investigating these samples was, as mentioned before, to find out more about the environment. Such questions were asked as were there any differences in the samples from around the periglacial structures compared to the samples taken from between these structures and if there were, could some species be identified as being more resistant or adapted to possibly colder climate?

But first, before tackling these questions, a brief explanation of what is necessary to extract the spores and pollen from the sediments might be in order. The “after-life” of fossil spores and pollen can be quite stressful. First they are boiled in hydrochloric acid to get rid of the carbonates, then they get immersed and left (for five days) in hydrofluoric acid (to dissolve all siliceous material), then oxidised and ammonia washed. Finally, they are subjected to a heavy liquid separation, with the residue being mounted on slides. Surviving a “chemical blast” like that indicates clearly that spores and pollen are quite sturdy individuals.

As mentioned above, the first sample studied gave promising results and so did subsequent samples. The residue left after the heavy liquid separation had to be diluted substantially in most samples in order to be able to mount the grains in such a way that they could be viewed under the microscope as individual grains and not as giant “blobs” of grains sticking together.

Results:
Lowest biodiversity (lowest amount of different species per sample) was generally found within the organic bands. This was expected since these layers were deposited in very low energy settings. One sample has been interpreted as being a swamp deposit. Here the grains of the spore species *Cyathidites australis,* (a fern), are stuck together in clusters indicating extremely low energy or even still water environment. All other lithologies (that is sediment types as in claystones, silty claystones…) contain up to 21 different species per sample. The periglacial (or cryoturbation) structures show low to moderate biodiversity.

Sites were compared to a site of similar age, the Kilcunda Cliff to the west, investigated by Barbara Wagstaff in 1983. All samples were taken from an area about 17 to 18 metres above yet another cryoturbation. Obvious is the higher diversity at the Kilcunda. 47 different species were identified as opposed to a combined maximum of 33 species in all of the Flat Rocks Sites. Furthermore, the amount of spore and pollen grains retrieved from the Kilcunda Site can only be considered fair. Almost a third of all samples were barren, as opposed to about 5% at the Flat Rocks fossil site. Flat

Rocks exhibits exactly the opposite characteristics: There is a lower species diversity but an abundance of individual grains.

Australia at time of deposition of the Flat Rocks sediments was situated quite close to the South Pole. It not only endured quite cold temperatures but also roughly 3 months of polar night. Taking into account that the Kilcunda samples were collected from an area above one of the cryoturbation structures and the samples at Flat Rocks from within and around such periglacial structures the following, tentative interpretation, can be made: Although Kilcunda was still subjected to a cool climate, it experienced an overall slightly warmer temperature regime. Biodiversity is higher with species being less stressed by extreme cool conditions. At Flat Rocks the temperature was probably lower than at Kilcunda. Species occurring there had to have cold temperature tolerances. Hence, there are less species and a high number of individual grains. However, the large number of grains could simply be due to closeness to the source plant rather than being directly linked to temperature.

In order to get a more complete environmental picture more samples need to be taken. There are, luckily, at least 3 more cryorturbation structures within the vicinity of the Flat Rocks locale. Two of these structures are found in the cliff face towards Inverloch and should be relatively easy to sample as opposed to the third one that is usually covered by a thick layer of beach sand and, so far, has only ever been observed once. It is important to look more closely at samples between these cryoturbations. Some of the periglacial structures are several hundred meters apart. If, when all these samples are prepared and investigated, it turns out that, generally, in and around every periglacial structure the species diversity drops and in return the species diversity in the long stretches between the cryoturbations increases again, then the above mentioned interpretation is strengthened.

Research Update by Tom Rich

A unexpected opportunity in December, 2002, to visit the vertebrate palaeontological collections at the Museum of Paleontology, South Dakota School of Mines, the Peabody Museum of Natural History, Yale University, and the Department of Paleontology, American Museum of Natural History allowed me to compare thirty specimens from Flat Rocks with actual dinosaur specimens housed in those three institutions. As a result, I was able to identify a number of specimens as individual bones or bone fragments from the skulls of small theropod and hypsilophodontid dinosaurs. In addition, I found that some of the fossils from Flat Rocks do not have obvious counterparts in any of the fossil vertebrates in those collections likely to have had representatives in the Cretaceous of Australia. So, what those enigmatic specimens are will probably only be determined if and when more complete material is found. These tantalising specimens are one of the reasons that work continues at Flat Rocks year after year. We know that there are interesting fossils to be found if the effort is made and slowly such fossils are coming to light because of the perseverance of the volunteers, who put in two person years of effort each summer at Flat Rocks.

A toothless specimen of the monotreme *Teinolophos trusleri* found in 2002 is proving to be just such an important fossil. Currently, there is a controversy about the relationship of the egg-laying monotremes to the marsupials and placentals. Some scientists think that (1) monotremes are more closely related to marsupials than that group is related to placental mammals. Others favour the idea (2) that while marsupials and placentals are closer to one another than either is to the monotremes, the monotremes separated from their common stock only shortly before they in turn split apart. A third position is (3) that monotremes separated from the common stock of placentals and marsupials long before those two groups in turn separated from one another. These different views are advocated both by workers investigating the gross anatomy of these different mammals and others comparing the DNA and RNA of the various groups.

That toothless jaw of *Teinolophos trusleri* adds a new piece of information relevant to this controversy. The specimen is currently being analysed by Prof. James Hopson of the University of Chicago, Ms. Anne Musser of the University of NSW together with Tom Rich. In the immediate ancestors of the mammals, there was not just one bone (the dentary) in the lower jaw as is true of all living mammals, but seven. In becoming mammals, some of these additional bones were simply lost while others were incorporated into the structure of the middle ear. What this specimen of *T. trusleri* shows is evidence for three additional bones in the lower jaw besides the dentary. The evidence consists of facets on the dentary where these additional bones were lodged in life. This is the first monotreme that shows evidence for the presence of any bone in the lower jaw besides the dentary. One of the three additional bones became part of the middle ear of all the living mammals. This means that the monotremes must have split apart from the common stock of marsupials and placentals at a primitive stage where the transition in function of this bone had not taken place. As marsupials and placentals are thought to have split apart only after all the bones of the middle ear had evolved to fulfill that function, a more advanced stage, this new evidence supports the third viewpoint, namely that monotremes separated from the other mammals long before they separated from one another.

New molecular evidence relevant to this controversy is continually being brought forward. Quite in contrast, most of the morphological evidence germane to this argument has been known for a century or more. So, new data like this toothless jaw of *T. trusleri* is an extremely rare addition to the argument indeed.

Four hypsilophodontid jaws were found at Flat Rocks during 2003. Three of them each have a single tooth that is unlike any previously found. Whether this is a new hypsilophodontid or one previously known to us only from its femora is uncertain. But again, it shows that continued effort will turn up new things if the effort is made.

<u>Detective Work by Danielle Shean</u>

William Hamilton Ferguson was born in Emerald Hill, Victoria, now known as South Melbourne, on 28th July 1857. His family emigrated from Scotland during the early 1800s and moved to Talgarno, NSW in the 1880s after the death of Ferguson's father (M. Doring, pers. comm., 1998). Ferguson left school at fourteen years of age and educated himself further through textbooks, more specifically geology, mapping and astronomy (M. Doring pers. comm., 2002).

W.H. Ferguson (Fig. 1) joined the Victorian Geological Survey (VGS) in 1891. He attained the rank of assistant field geologist in the Survey and was deployed throughout the widely unexplored state of Victoria to carry out field mapping. In his thirty-five year tenure with the VGS he was responsible for the documentation of approximately 6000^2 miles of previously unmapped geology (Ferguson, self-written report, 1950). Ferguson was also responsible for the discovery of fossils such as Silurian marine invertebrates in the Grampians, fish beds near Mansfield and Briagolong, fossils in Moonee Ponds, Lancefield, Wombat Creek, Foster, Inverloch, Eagle's Nest, Daylesford, Lethbridge, Maude and Bacchus Marsh. He reported the discovery of gold in Benalla, Dunolly, Foster, Blakeville, Moliagul, Towong, Wongunyarra River, King River and Blackwood. He discovered deposits of black coal, brown coal, oil, opal, pottery clays, copper, antimony and lead. W.H Ferguson also reported glacial conglomerates, sandstones, granites, limestones, soapstones, volcanics, greenstone and dykes to name but a few geological phenomena throughout Victoria (Ferguson, list of published and unpublished reports 1891 – 1926).

Probably his most consequential discovery was of the first genuine dinosaur bone from Australia in 1903.

It was during his surveying in the early 1900s that Ferguson developed a new interest – fossils. He found and recorded a significant number of graptolites in the western parts of Victoria. He also discovered fossil fish near Mansfield and Briagolong, marine sequences in the Grampians and Buchan, 'fossil fruits' in the Foster and Inverloch area, Cambrian fossils in Heathcote, Early Ordovician fossils near Boolarra and Late Ordovician fossils at Lucyvale (Ferguson, 1891 – 1926).

Ferguson found an incomplete portion of a claw from a 'Jurassic' megalosaur.Until now, this has previously been determined to have been discovered in 1906, based upon the information of both the Quartersheet from Memoirs No. 8 and from the paper dated 1906 'On a Tooth of Ceratodus and Dinosaurian Claw from the Lower Jurassic of Victoria, Australia.' written by English palaeontologist A.S. Woodward (Dunn, 1907).

However, in a list of written works by Ferguson; Ferguson himself lists a title 7/5/1903 'Inverloch tooth of reptile etc few Ceratodus 1st point West Eagle's Nest' (Ferguson, list of reports, circa 1910). This is the only specific reference in any of Ferguson's journals for Eagle's Nest, although there are multiple references in his journals for Inverloch. It could be logically assumed that the megalosaur claw may have been mistakenly reported as a 'reptile tooth'.

William Hamilton Ferguson was a man of incredible accomplishment and knowledge. His record of fossil collection is outstanding, as was his knowledge of outback Victoria. His work enabled future generations of geologists to understand the rich geological history of Victoria. If not for his tireless efforts, much of Victoria's geology would never have been recorded or interpreted during his lifetime. Ferguson's contributions to science and industry, as well as the emerging Victorian society, were considerable and it is appropriate that this unsung hero of the Victorian geology receives the credit he so richly deserves during this 100th anniversary year for Australia's first found dinosaur..

I found a mammal jaw!
4 Days on Dinosaur Dreaming 2003 as seen by Wendy White.

I arrived at the dig at the beginning of week two when "the system" was set up and the fun part of breaking rocks and finding fossils had just begun. Low tide was quite early in the morning, so we were down on the beach each dawn when I arrived. A short aside here about how beautiful dawn was from Flat Rocks. Because of the bushfires, there was a lot of dust in the air, which meant that the sun was a red orb rising over the ocean. Wading birds searched the shore-line for breakfast, and the days were full of possibility.

It was week two of my term on the dig. We'd just had "Friend's Day", as part of a busy weekend with Inverloch locals and people from all over the place coming down to Flat Rocks to see what we were doing. As a returning rather than a new volunteer, I'd been learning from the old timers and was beginning to enjoy talking to the passers-by about dinosaurs, the Early Cretaceous, river beds and "the system". I'd just about learnt to say *Ausktribosphenos* but still needed to take a deep breath at the beginning or somehow ran out of steam halfway through.
I was sitting on the beach breaking rock. The fossiliferous rock is a conglomerate layer, and full of:

- coal (black and shiny, sometimes leaves a brown imprint)
- mud (often brown)
- wood (brown twigs)
- small stones
- "beetlebums" – a mineral inclusion surrounding a lump of stone or mud
- other things
- and fossils.
-

I'm amazed how much difference the extra year makes. My "eye" (the ability to determine what's a fossil amongst all the other stuff; and even what sort of fossil) was improving in leaps and bounds. Last year I was asking others to check strange things in the rock every few minutes – this year I only really had to get a second opinion the more unusual stuff such as,

- bony wood
- woody mud
- odd-shaped beetlebums
-

I was really enjoying myself. The weather was beautiful, and I was seeing critters that no human had ever seen before. Critters that lived for only a few years, 115 million years ago, whose bones and teeth and shells and scales had been waiting ever since buried in rock. It's exciting and humbling, and makes even the broken turtle and fish bits (that are not really being intensely studied by any of the scientists yet) very special.
It was week two of my dig term. We'd found some pretty cool fossils while I was there – Dale found a beautiful plesiosaur tooth with an amazing long root, and we'd got a couple of hypsilophodont jaws and some attractive theropod teeth. But we had no mammal jaws yet. And they're exciting. Our cute little Early Cretaceous mammals just weren't really supposed to be there. Dr Tom Rich needed more of them so he could discover more about exactly what they are.

I was sitting on the beach breaking rock. I'd broken my current rock down to about emu egg size. I hit it once more and exposed a skinny something, brown, about 2 cm long. I had a closer look. The brown thing was filled with kaolinite for most of its length, with something I didn't understand at one end. Kaolinite is a white chalky material that seems to have filled a lot of cavities in our particular rock.

I showed it to Nicole (a self-confessed white-haired grandmother who likes finding things), sitting next to me and renowned for having a pretty good "eye".

"Interesting", she said. "Well done." (Nicole often says "well done".) "It's definitely bone. Go show Lesley. I think I see teeth". Teeth, I thought to myself – how does anyone see teeth in such a tiny scrappy fossil. I looked at it again, shrugged (carefully, since it was "interesting"), and took it up to Lesley.

Lesley Kool is the dig leader and spends the rest of the year preparing the fossils we find for Monash University (some also are prepared at the Victorian Museum). She is the final word on all things we find in the rock.

In order to find a fossil, we have to break it. The important thing we do is make sure we have both halves, so that they can be glued back together. That gives the scientists a complete bone (or as complete as it was 115 million years ago) to learn things from. Sometimes when we break a rock, the cross-section of the fossil exposed is so small that, no matter how carefully we check, it is missed until after the rock as been struck and broken again. Fossils are quite fragile, much more fragile than the rock. Sometimes when we break a rock, the fossil shatters into a number of tiny pieces. Lesley is the one who decrees how hard we search for "the other half".

Some fossils we find are unlikely to add much to the body of scientific knowledge. An incomplete fragment of something larger (such as turtle plate) is unlikely to be worth describing – something more complete, or anything from the skull or jaw, is far more likely to be described and to be diagnostic. A fossil is referred to as "diagnostic" if it is a good indicator as to what the species is. Jaws with teeth in them are probably best for most vertebrates, skulls are good, limb bones are good only if the ends are complete so that the scientists can work out what the ranges of movement are.

Lesley will decide if we are picking up every scrap of a splintered fossil with tweezers, looking at our breaking surface through a hand lens and examining each fragment of the rock. Lesley decides if we have to look through a bucket of rubble for a missed "other half". In fact earlier in the week, half a hypsi jaw was found, and three people spent hours looking for the matching half. (I'd actually had it for most of that time, neatly circled on the side of a big rock I was trimming).

So I took my "interesting" fossil to Lesley. Lesley gave it a preliminary designation as a fish jaw, but decided that it deserved a look through a decent microscope when she gets home. So I went back to break more rock.

We have a tradition on the dig called "bone of the day". Each day, Lesley awards one find "bone of the day". It is nearly always a jaw or tooth, if one has been found. One of the new volunteers, Neil, had been awarded "bone of the day" for the last two days, and was awarded it again for something more important than a little fish jaw.

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Next morning, we are up at the house breaking rock. I'm giving Neil a hard time, since I'm a little jealous of "bone of the day" three days in a row. We gave him a lump of (modern) concrete and told him to break that and give the rest of us a chance! Then Lesley arrives.

Apparently, in a miraculous feat of speed-evolution, my fish jaw had evolved into a mammal overnight merely by the application of a good microscope.

I grin from ear to ear. I gloat. Lesley sets my fossil up under the house microscope and we all look at it. It still looks like a funny little scrappy bone to me – the teeth are broken through the roots, not anywhere beautiful and shiny.
Lesley speculates about what it is. There are basically four options:

- a monotreme (about 6 of the 20 mammal jaws previously found had been monotremes)
- an *Ausktribosphenos*
- a *Bishops*
- something new

The cross-section is very narrow – we think it's a *Bishops*. The decision is taken to send the jaw back to the museum with Dave on Saturday and see what Tom says. He says Dave's going to prepare the fossil at the museum.
I go home and back to my day job and wait.
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A couple of weeks later I head back down to Inverloch for the party. Many of the crew return for the last full weekend of the dig.
"Well?", I say the moment Dave arrives. "How's it looking?" Tom is down as well, so I pump them both for information.
For a while, it was thought my jaw was something entirely new. It had broken at quite an odd angle. But as Dave prepared it, it became clear that this was an *Ausktribosphenos*.
"Oh", I said. "Is that disappointing?"
The jaw was incomplete. It had got a little damaged 115 million years ago (not my fault). I should have guessed that because of the kaolinite infill.
But it's still a good find – and will teach us more about the species. Besides the two molars that were visible on the broken fossil, my jaw had a premolar tooth close to the front. The number of pre-molars will give extra evidence of the Ausktribosphenos being placental. And the preparation was still incomplete – maybe we'll even get an incisor!
***
A couple of months later I phone Dave and meet him at the museum to visit my fossil. The vertebrate palaeontology collection not on display is buried underneath the Exhibition Building. Dave fires up the good microscope and pulls out my jaw – still largely buried in rock!
Dave explains that he only works on the jaw for short periods because it is so little. He also explained that the priority directly after the field season was to expose enough of the unidentified bits to determine if we have turned up anything truly new. Then interesting but described stuff like my jaw gets done next.
However, I could see the premolar through the microscope, as well as the other two teeth. And I'm now an old hand at pronouncing *Ausktribosphenos nyktos* as I tell all my friends how I spent my summer vacation.
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Once again we have been very fortunate to be sponsored by the National Geographic Society, which has been a long-standing supporter of the research carried out by Dr. Tom Rich and Professor Patricia Vickers-Rich.
Thanks also to the Australian Research Council whose five year grant has provided the stability and continuity to the Dinosaur Dreaming project.
Blundstone Pty. Ltd of Tasmania generously provided steel-capped boots to all members of the crew, promoting the work safety ethic.
We thank Atlas Copco and Ingersoll Rand for supplying the heavy equipment to allow us to install Nick's system, which worked so efficiently this year.
Special thanks go to Andrew Plant who designed the unique artwork on the crew T shirts – a wonderful "*Megalosaurus*" with Eagle's Nest in the background.
Last but not least, the ongoing support from the Friends of Dinosaur Dreaming, both financially and morally, make the overall running of the dig that much easier.

DINOSAUR DREAMING 2003 WAS PROUDLY SPONSORED BY:

Atlas Copco
Australian Research Council
Blundstone Pty. Ltd
Bunurong Environment Centre
Denis Hawkins, Leongatha
Friends of Dinosaur Dreaming
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Monash Science Centre
Monash University Research Fund
National Geographic Society
Peter Trusler, Melbourne
Ziggurat Creative & Technical Publishing
Geological Society of Australia (Victorian Branch)