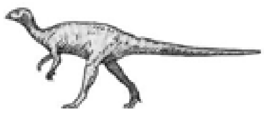
DINOSAUR DREAMING
2020 FIELD REPORT



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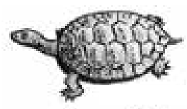

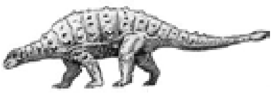

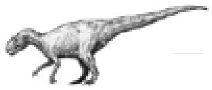

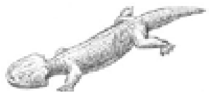

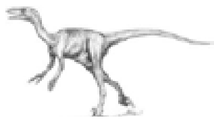

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Dinosaur Dreaming acknowledges the Bunurong and Eastern Maar peoples, the Traditional Owners of our Victorian Cretaceous dig sites, and pays respect to their Elders past and present.

FRONT COVER: Reconstruction of the new Victorian elaphrosaurine by Ruairidh Duncan.
INSIDE FRONT COVER: Cretaceous animal images by Peter Trusler.
BACK COVER: Dreaming of Dinosaurs by Sharyn Madder.

Collection of Victorian Cretaceous material is completed under the National Parks Act 1975 Research Authorization Permit No 10009432 from the Department of Environment, Land, Water and Planning granted to Prof Patricia Vickers-Rich, Monash University, 9 Rainforest Walk, Clayton, Victoria, and associates under the direct supervision of the authorisation holder.
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The Dinosaur Dreaming 2020 Field Report was compiled and edited by Wendy White. The editor would like to thank her proofreaders Lesley Kool, Stephen Poropat and Mary Walters.

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Image: Museums Victoria

Postponed and Future Digs

By Tom Rich

With the brief exception of a short dig in November 2019 that saw one day of favourable weather, the customary three week dig at the Eric the Red West site has not occurred since 2017. This has not been owing to lack of desire. Quite the contrary. Rather a litany of misfortunes has prevented the desired return.

Three fossil discoveries over a span of seven years have prompted this desire. The most recent was a high concentration of fossil bone unlike any encountered previously in four decades of work in the Victorian Cretaceous, the single rock containing these fossils known as The Block (recounted in the 2017 Field Report). If that concentration continues, it could well be that far more material will be found than has ever before in a comparable length of time. The single productive day in November 2019 supports the idea that the concentration of bones in The Block is not unique.

By contrast, the other two fossil discoveries were single specimens of poorly preserved fossil mammals both unlike any previous found in the Victorian Cretaceous in one important respect: they are upper molars. Of the 55 mammalian specimens found at the Flat Rocks locality, none are upper molars. Upper molars have the potential to provide insights into the nature of the mammals they come from that can significantly augment understanding of the same animals based on the evidence from lower dentitions.

Flat Rocks, although the most prolific Australian Mesozoic mammal locality known, has never yielded a single mammalian upper molar and Eric the Red West has yielded two such specimens.

The two specimens of upper molars were found by Alanna Maguire in November 2009 and Tim Ziegler in February 2015. Although both were recognised immediately to be significant owing to their being upper molars, their study and analysis was long not completed because of their fragmentary nature. In the meantime, the hope had been that with continued work at Eric the Red West, better preserved examples of these two different mammals would be found.

Years passed, and then the bush fires followed by COVID-19 further delayed a return. Therefore the decision was made to no longer put off the description and analysis of these two intriguing fossils. The manuscript about them has now been submitted to the Australian palaeontological journal *Alcheringa*. It is replete with cautions about the very tentative hypotheses presented. But the information about them will be available to future researchers and if nothing better is ever found, there will be an awareness that such fossils exist.

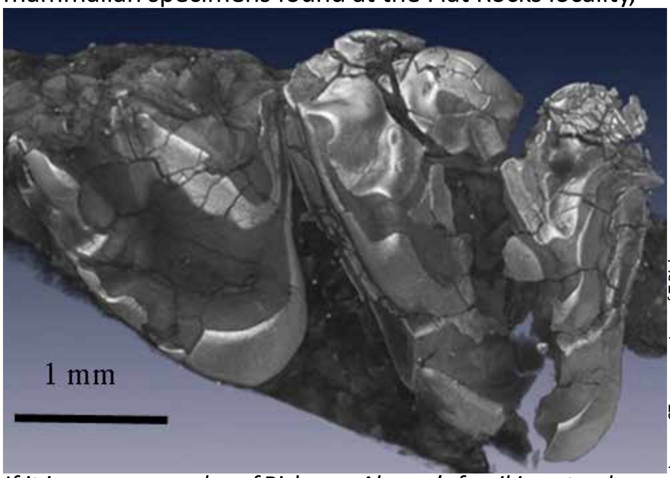

Image: CT scan courtesy of T Rich

If it is an upper molar of Bishops*, Alanna's fossil is not only the first upper molar of an ausktribosphenid known but also the first of any mammal from the Mesozoic of the southern hemisphere that have lower molars resembling those of ausktribosphenids. A lower jaw of* Bishops *is also known from Eric the Red West.*

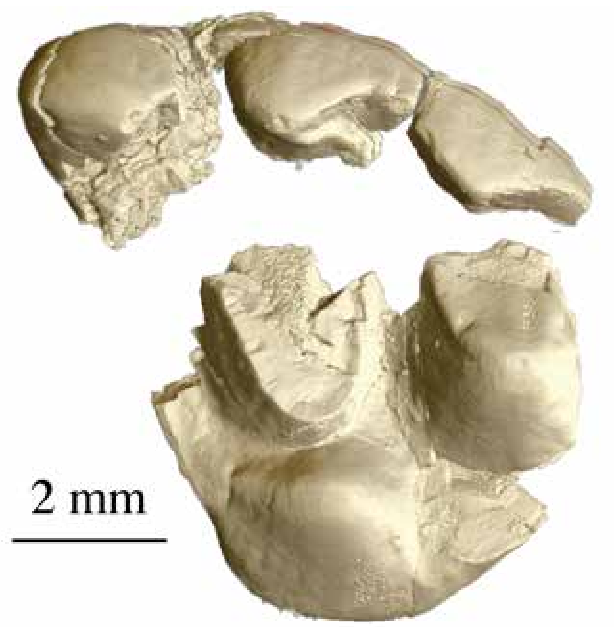

Image: CT scan courtesy of T Rich

Very tentatively, this specimen of Tim's may be a monotreme perhaps distantly related to a younger one known from Lightning Ridge, Kollikodon

The Mammals of Victoria's Cretaceous

As long-time Dinosaur Dreaming diggers can attest, the tiny fragments of Cretaceous mammals that we find are celebrated and prized. But mammal jaw (and other element) finders don't always get to find out what became of their precious scrap. Here is a list of all confirmed mammal fossils from the Victorian Cretaceous, with their Museums Victoria catalogue numbers, notes and taxa.

Reg #	Taxonomy	Collector	Field Number	Year	Preparator	Notes
P208090	*Ausktribosphenos nyktos*	N. Barton	#1111	1997	L. Kool	HOLOTYPE. Right. P6, M1-3
P208094	*Kryoryctes cadburyi*		Dinosaur Cove	1993	L. Kool	HOLOTYPE. Right humerus. Slippery Rock Pillar, Dinosaur Cove
P208228	*Bishops* sp.		#329	1995	L. Kool	600my Exhibition display. Right. P4-M2
P208230	*Ausktribosphenos* ?			1995	L. Kool	Edentulous jaw fragment
P208231	*Teinolophos trusleri*		Mentors trip	Nov. 1993	L. Kool	HOLOTYPE. M3 or M4
P208383	Monotremata		Dinosaur Cove	1993	L. Kool	Premolar. Slippery Rock Pillar, Dinosaur Cove
P208482	*Ausktribosphenos nyktos*	N. Gardiner	#150	1999	L. Kool	Right. M2-3, badly crushed. Found in rock from DD1998
P208483	Ausktribosphenidae ?	N. van Klaveren	#140	1999	L. Kool	Probably Left. x1 premolar & partial tooth
P208484	*Bishops whitmorei*	K. Bacheller	#450	1999	L. Kool	Right. M2
P208526	*Teinolophos trusleri*		#560	1994	L. Kool	Right. Edentulous
P208580	Mammalia	A. Maguire	#200	2000	L. Kool	Jaw fragment. (unprepared)
P208582	Ausktribosphenidae	L. Irvine	#500	2000	L. Kool	Right. M3
P209975	*Bishops whitmorei*	R. Close ?	#387	2000	L. Kool	Right. Roots M1, worn M2. OK M3
P210030	*Teinolophos trusleri*			2000	L. Kool	Right. Edentulous
P210070	*Bishops whitmorei*		Rookies day	03.12.2000	L. Kool	Right. Badly broken M1, M2 and x6 Premolars
P210075	*Bishops whitmorei*		Rookies day	03.12.2000	L. Kool	HOLOTYPE. 600my Exhibition display. Left. P2-6, M1-3. (P1 lost since initial preparation)
P210086	Ausktribosphenidae ?	J. Wilkins	#250	2001	L. Kool	Right. Root fragment
P210087	"Gerry's jaw"	G. Kool	#620	2001	L. Kool	Right. Rear half M1, M2-3
P212785	Mammalia	M. Anderson	Rookies day	03.12.2000	L. Kool	Fragment only
P212810	*Bishops whitmorei*		#300	2002	L. Kool	Left. M2-3
P212811	*Teinolophos trusleri*	D. Sanderson	#187	2002	L. Kool	Right. Edentulous
P212925	Mammalia ?		#222	1996	D. Pickering	Edentulous
P212933	*Teinolophos trusleri*		#179	2001	L. Kool	Left. Edentulous. (Plus associated molar)
P212940	"Gerry's jaw"	W. White	#171	2003	D. Pickering	Left. M1, M2-3
P212950	*Bishops whitmorei*	C. Ennis	#292	2003	L. Kool	Left. P6, M1-3
P216575	*Teinolophos trusleri*	N. Gardiner	#180	2004	D. Pickering	Left. x2 molars. Probably M2-3
P216576	Mammalia	A. Musser	#500	2004	L. Kool	Isolated tooth
P216578	*Bishops whitmorei*	A. Leorke	#600	2004	D. Pickering	Left. M1-3
P216579	*Teinolophos trusleri*	N.van Klaveren	#635	2004	L. Kool	Edentulous jaw
P216580	*Bishops whitmorei*	G. Kool	#800	2004	D. Pickering	Right. P6, M1-3
P216590	*Teinolophos trusleri*	J. Wilkins	#447	2004	D. Pickering	Posterior part of right edentulous jaw
P216610	*Teinolophos trusleri*		#557	2004	L. Kool	Left. Edentulous
P216655	*Corriebaatar marywaltersae*	M. Walters	#142	2004	L. Kool	HOLOTYPE. Multituberculata. Left. P4
P216670	*Ausktribosphenos nyktos*		#184	1999	L. Kool	Left. M2-3
P216680	*Teinolophos trusleri*	R. Long	#132	2004	L. Kool	Right. Fragment
P216720	*Teinolophos trusleri*		#648	2002	L. Kool	Right. Edentulous
P216750	*Teinolophos trusleri*	R. Long	#162	2005	D. Pickering	Right. Edentulous
P221043	*Bishops whitmorei*	A. Leorke	#100	2005	D. Pickering	Right. M1-2?
P221044	Ausktribosphenidae	C. Ennis	#300	2005	D. Pickering	Left. M2
P221045	*Teinolophos trusleri*	J. Wilkins	#395	2005	D. Pickering	Right. Edentulous
P221046	Mammalia	H. Wilson	#480	2005	L. Kool	Isolated tooth
P221150	*Teinolophos trusleri*	J. Swinkels	#340	2006	D. Pickering	600my Exhibition display. Right. x2 molars. Probably M2-3
P221156	Ausktribosphenidae	N. van Klaveren	#360	2006	D. Pickering	Right. M2 (requires preparation to confirm)
P221157	*Bishops whitmorei*	M. Walters	#585	2006	D. Pickering	Right. Edentulous with alveolae for P6, M1-3
P221158	*Bishops whitmorei*	R. Close	#200	2006	D. Pickering	Right. P5-6, half M plus M2-3
P228432	Ausktribosphenidae		scrap rock	2009	L. Kool	Right. Molar talonid
P228848	*Bishops* sp.	M. Walters	ETRW, Otways	10.12.2006	D. Pickering	Left. P6, M1, partial M2
P229037	*Teinolophos trusleri*	M. Cleeland	#91	2008	D. Pickering	Right. Edentulous with alveolae for x4 molars and ultimate premolar
P229194	Mammalia	N. Barton	#770	07.03.2007	D. Pickering	Isolated upper Premolar
P229408	*Teinolophos trusleri*	M. Walters	#300	14.02.2008	D. Pickering	Left. Ultimate premolar, M1-4
P229409	Ausktribosphenidae	N. Evered	#180	07.02.2007	D. Pickering	Possibly *Bishops whitmorei* . Left. P5-6, M1-3
P229410	*Teinolophos trusleri*	C. Ennis	#90	2008	D. Pickering	Right. ?M1 plus M3
P229649	*Bishops whitmorei*	J. Tumney	#330	2009	D. Pickering	Right. P2-3,5-6, M1-3
P231328	*Bishops* ?	A. Maguire	ETRW, Otways	29.11.2009	D. Pickering	Maxilla fragment with x2 molars
P232567	*Ausktribosphenos* sp.	M. Walters & J. Wilkins	#270	26.02.2012	D. Pickering	Right. Broken premolars. M1-3
P232892	*Bishops* sp.	A. Werner		16.02.2013	D. Pickering	Left. ?M2
P252052	"Tim's tooth"	T. Ziegler	ETRW #626	20.02.2015	D. Pickering	Upper premolar
P252207	*Bishops* sp.	O. Campbell	ETRW #200	07.02.2015	D. Pickering	Posterior part of right mandible w x1 molar
P252730	*Corriebaatar marywaltersae*	W. White	Tragics day	11.11.2017	L. Kool	Left. P4
P256479	Mammalia	M. Walters	Tragics day	15.12.2019	L. Kool	Fragment with single tooth

Cretaceous Vertebrate Localities in Gippsland

By Lesley Kool and Melissa Lowery

TAXA	San Remo Back Beach	Potters Hill	Rowell's Beach	Skull Cove	Punch Bowl	The Haybaler	Andrew's Beach	Orbital site	Tree Trunk Point	The Arch	Black Head	Kilcunda	Powlett River	Harmer's Haven	Wreck Beach	F Break	Cape Paterson	The Oaks	Twin Reefs	Shack Bay	Lesley's Lair	Tom's Layer	Ferguson's Layer	Eagles Nest	Halfway Headland	The Honey Locality	The Caves	Flat Rocks	Swim O'clock Rock	Ankylosaur Point	Noddyland	RACV Point	Mary Anning	Kirrak	Melissa's Mine	Bena	Koonwarra
Mammalia:																																					
Australosphenidae (Unidentified)																												■									
Ausktribosphenos nyktos																												■									
Ausktribosphenos sp.																												■									
Bishops whitmorei																												■									
Monotremata (Unidentified)																												■									
Teinolophos trusleri																												■									
Multituberculata (Unidentified)																												■									
Corriebaatar marywaltersae																												■									
Dinosauria:																																					
Dinosauria (Unidentified)	■	■	■		■			■	■	■	■	■	■	■	■	■		■		■	■	■	■	■	■	■	■	■	■	■	■		■		■	■	
Ornithopoda (Unidentified)	■	■			■					■	■	■	■	■	■			■		■		■	■	■		■	■	■	■	■	■	■	■				
Fulgurotherium australe										■														■													
Galleonosaurus dorisae																						□					■	■		■							
Qantassaurus intrepidus																												■									
Ankylosauria										■				■														■		■			■				
Neoceratopsidae (Unidentified)																																					
Serendipaceratops arthurcclarkei										■																											
Theropoda (Unidentified)	■				■					■	■	■	■							■	□			■	■			■									■
Megaraptora										■													■	■				■									
Ceratosauria:Noasauridae	■																																				
Aves (birds)																												■									■
Other Vertebrates:																																					
Plesiosauria (aquatic reptiles)	■		■										■										□	■				■					■				
Pterosauria (flying reptiles)																						□		■	□			■			■						
Testudines (turtles)											■		■				■				■	■		■	■	■	■	■	■		■	■	■		■	■	
Temnospondyli (amphibians)	■	■	■	■	■	■	■	■	■							■	■																				
Koolasuchus cleelandi	■	■	■		■																																
Dipnoi (lungfish)	■				■							■	■							■			■	■	■			■		■	■			■			■
Neoceratodus nargun					■																			■				■									
Archaeoceratodus avus																								■													
Actinopterygii (ray finned fish)										■	■		■									■	■	■	■		■	■	■	■	■		■	■		■	■
Coccolepis' woodwardi																																					■
Koonwarria manifrons																																					■
Psilichthys sp.																																					■
Wadeichthys oxyops																																					■
Waldmanichthys koonwarri																																					■
Trace Fossils:																																					
Dinosaur footprints																			■							■		■	■			■					

Key: ■ fossil from locality identified; □ fossil from locality tentatively identified

Maps: Google Earth
Data: SIO, NOAA, US Navy, NGA, GEBCO, Landsat / Copernicus, CNES / Airbus, Terrametrics

Image: J South

Prospecting Report

By Mike Cleeland

Stop! Hold it right there. Make yourself a cup of coffee, select a comfortable armchair, pull up a rug over your knees and settle in for a long read. This year's prospecting report is going to be a bumper edition.

In fact, it would be fair to say that the 2019–20 period has been one of the three best for prospecting in the Victorian Cretaceous. It has been rivalled only by 1978–79, the period of the original search of the Cretaceous coastline by Tim Flannery, Mike Archer, Tom Rich and others culminating in the discovery of Dinosaur Cove, and 1990–92 which saw the discovery of *Koolasuchus*, the Dinosaur Dreaming dig site and several other significant sites.

2020 saw Melissa Lowery reach new heights in her prospecting particularly around the Inverloch area, having now discovered over 200 bones including her first two ornithopod mandibles and some dozens of footprints. She has deservedly acquired the name "Electron Microscope" for her unsurpassed capacity to spot bones down to a few millimetres in size.

At one stage I decided to write a list of the top ten bones found this season, but by the time I'd finished it had become the top 20! Highlights of these follow.

A combination of sand removal and steady erosion of relatively soft rocks at several Inverloch sites have worked in Melissa's favour, as well as the long hours she dedicates to her pursuit. This has resulted in other interesting finds including a large fish operculum about the size of the palm of her hand, a small pterosaur wing bone, five bones and a lungfish tooth at San Remo Back Beach, and a very interesting but hitherto unidentified bone from Lesley's Lair that could yet turn into a skull fragment. The same locality produced a rare example of articulated bones, with three small metatarsals being found grouped together in a discovery that gives promise for more results from this steadily eroding site.

Extensive erosion along the Inverloch foreshore driven by longshore drift to the east has removed vast amounts of sand from Flat Rocks and transported it east towards Point Smythe. This has resulted in the exposure of several bones and a promising new site named Melissa's Mine, which had eight small bones exposed on the surface when Melissa found it and continues to produce more as erosion of the soft rock continues.

The Arch at Kilcunda has a long history of revealing interesting bones including the holotype of *Serendipaceratops*. More recently it produced a theropod tooth and an ankylosaur scute.

Little prospecting was done in the Otways this season except for Simona Grippi finding an interesting limb bone at Marengo, and Tim Godfrey discovering a fine theropod footprint at Cape Volney, being the first Cretaceous fossil recorded from that locality. Moulds were also made of the footprints at Browns Creek to ensure that their structure would be protected against erosion or damage.

A day trip to Dinosaur Cove in June by Pip Cleeland, Simona, Tim Godfrey and myself resulted in the collection of five bones and a nice footprint, currently being moulded by Peter Swinkels, with the cast soon to be sent off to Tony Martin for description. The site had not been searched for many years owing to the increasing difficulty of access through thick scrub overgrowing the original track, but the numerous erratics on the beach which originally derive from the fossil layer in the tunnels continue to erode and reveal occasional new bones. These specimens may prove to be the last to be collected from this site, as the encroaching vegetation will probably become impenetrable within the next few years unless track clearance is undertaken. Bone of the Day went to Simona for her discovery of a dinosaur limb bone in one of the erratics.

A new site on the Mornington Peninsula was located in June this year when Tim Flannery found the small Cretaceous outcrop on the shore of Port Phillip Bay near Sunnyside Beach. Tim thought he had seen an exposed bone at the site, but when a prospecting party visited it we ran into a high tide and couldn't see the bone.

Image: M. Cleeland

Bone found by Melissa Lowery in a concretion near Eagle's Nest

Hopefully future visits to the area by observant locals will reveal whether Tim has actually found the first Cretaceous bone in Port Phillip.

In 2018, a total of one definitive tetrapod footprint was known from the Strzelecki coast. This has now expanded to over thirty with Melissa's discovery of multiple small ornithopod and theropod prints at Flat Rocks, the Honey Locality and Twin Reefs. Further, a single large print she found at Flat Rocks measuring 49 centimetres in length of the middle toe rivals the Lark Quarry prints for the biggest theropod footprint known from Australia. Thanks to the efforts of Pat Vickers-Rich, Melissa, Lesley Kool and mould makers Peter and John Swinkels some of these have now been cast and preserved, and will, when circumstances permit, be the subject of detailed study led by Tony Martin.

Yet another highlight was Melissa's discovery, shared with Pat, of several blocks showing exquisite arthropod trackways, the first occurrence of this ichnology in the Victorian Cretaceous and perhaps for the whole of Australia. These too are currently the subject of a study involving Tom, Pat, Tony and Melissa along with photographer Steve Morton and geologist Mike Hall.

Not to be outdone, the temnospondyls had perhaps the best year since *Koolasuchus* arrived in 1990. Following Simona's discovery of an interesting probable Temnospondyl limb at the unlikely location of Harmer's Haven, on 19 April 2020 a party comprising Mike, Simona and Andrew Ruffin searched the otherwise unnamed cove immediately to the west of The Punchbowl. This site had previously produced the large claw fragment that has since been recognised as Victoria's largest megaraptoran, and it did not disappoint on the day. Mike's discovery of a temnospondyl mandible in the shore platform only about 5 metres from this site, was quickly followed by Simona's spotting a mostly complete temnospondyl skull in a large erratic, both of which were later removed in a special extraction operation on the iconic date of 7 May. The discovery of these two specimens represents, as far as is known, the first time a temnospondyl skull and jaw have been found on the same day in the Victorian Mesozoic, and preparation by Tim Ziegler at Museum Victoria and research on these by Tom, Pat, Tim Ziegler (on the close watch of Ben Kear and Anne Warren) is currently underway. Befitting this unique specimen, the site is now colloquially known as Skull Cove. Simona's discovery of this skull, together with her finds in Argentina earlier in the year, have deservedly earned her the title of the "Bone Magnet".

Turtles were also well represented this season, the highlight being Melissa's discovery of a nearly complete skeleton near the Honey Locality. This valuable addition to the collection will enable Lesley's research to examine more of the diversity of this fauna.

During 2020 an attempt was made to prospect the remote stretch of coastline between The Punchbowl and Kilcunda which had not been fully prospected for many years. This has now been all but completed with the assistance of Simona, Melissa, Nelma Lewis and John Wilkins.

Prospecting in coastal cliff areas can be hazardous, and a salutary reminder of this fact was received when a large rock fall blocked the entrance to the main cave at Inverloch in August. Fortunately nobody was hurt, but if the same event had occurred in summer with streams of tourists visiting the site there could have been numerous fatalities.

COVID-19 restrictions may curtail fieldwork for the short to medium term future, but 2020 has certainly taught us some valuable lessons. It reminded us of the importance of revisiting known sites, showed us that footprints are there to be found in the finer sediments, and surprised us with the discovery of the temnospondyl skull in almost pure sandstone. We dare to hope that the next 12 months will delight us with yet more treasures from the Lower Cretaceous.

Image: M Cleeland

Melissa Lowery with one of her finds at Halfway Headland, a new site between Eagle's Nest and The Caves

Image: Brian Martin, Parks Victoria

Rock fall at The Caves


Image: W White

The Bass Coast Prep Group

By Lesley Kool

The Bass Coast Preparation Group meetings were held on a regular basis during the months leading up to Christmas 2019 with an average of nine members attending each session. Following a break of four weeks over the holiday period I decided to start off the year with a Workshop in which I went over the various preparation techniques including embedding the fossil bones in CARBOWAX™ (Polyethylene Glycol) and discussed any problems the members were experiencing. This session was well received and resolved most of the questions that arose within the group.

The workshop was followed by a couple more sessions in early 2020 before the COVID-19 pandemic put an abrupt halt to our meetings. By June it became clear that travelling from Melbourne to Wonthaggi and meetings of more than a couple of people was prohibitive and at the time I am writing this report the Melbourne metropolitan area is in Stage 4 lockdown with movement severely restricted. I am hopeful that the group will be able to meet again in the future and look forward to what progress has been made in their preparation. Suffice to say that once we are allowed to meet again, another workshop is planned to help the members brush up on their skills.


Image: L Kool

Caudal vertebra prepared by Alison Dorman

Before the pandemic put our meetings on hiatus two of the members were working on bones from the Eric The Red West 2017 field trip. Experienced preparator Alison Dorman did a beautiful job of preparing a well preserved ornithopod caudal vertebra, complete with delicate zygapophyses. One of the founding members of the Dinosaur Dreaming project, Mary Walters, prepared a robust but oddly shaped vertebra that was identified by palaeontologist Steve Poropat as a partial ornithopod sacrum — a rare discovery at the site. Another member of the group, Judy Chelini, has spent many years as a volunteer preparator at the Australian Age of Dinosaurs in Winton, Queensland. She has worked on many of the enormous sauropod bones but actually prefers to work on small bones. Due to the travel restrictions placed upon Victorians Judy was unable to travel to Queensland in May as she has done for many years. Instead she took it upon herself to help me reduce the backlog of fossil bones from previous years' digs. She has set up a preparation laboratory at her home in metropolitan Melbourne, complete with the finest pneumatic preparation tools, and is diligently working her way through some of the small, tricky bones that she enjoys. Living on her own, she finds the preparation "keeps her sane" and I very much appreciate her help. Winton's loss is our gain.

Over the last twelve months, more than 250 bones and tracks have been found along the Bass Coast shoreline by Mike Cleeland, Melissa Lowery and Simona Grippi. These discoveries have really revitalised fossil hunting in this area and reflect the dynamic influence of coastal erosion.


Image: L Kool

Wendy White pours warm CARBOWAX™ into a plasticine wall built around a fossil

Image: L Kool

Ornithopod dentary from Ankylosaur Point near Inverloch

Many of the bones discovered by Mike, Melissa and Simona have been exposed on the surface of the shore platform for a period of time and are partially eroded. Sometimes they may be newly exposed and very little bone has been lost but often the bone has been exposed for a while and more of the bone has been lost. Our hope is that enough of the bone is preserved for us to be able to identify what is left, but unfortunately at least 50% of the fossil bones collected are too fragmentary to identify. However, during the last twelve months the team has made some spectacular discoveries including ornithopod dentaries and maxillae, a handful of ornithopod femora and a number of temnospondyl bones, including a partial skull and two lower jaws. The temnospondyl skull is currently being prepared by Museums Victoria Vertebrate Palaeontology Collections manager Tim Ziegler and one of the lower jaws is being prepared by long-time Museums Victoria volunteer preparator Paul Chedgey. We are keen to see if this new material is more of *Koolasuchus cleelandi* or a new species.

Image: M Cleeland

Melissa Lowery with her turtle near the Honey Locality

Image: L Kool

Partial ornithopod sacrum prepared by Mary Walters

Personally, the best fossil found in the last twelve months would have to be the nearly complete turtle shell, found by Melissa near The Caves, south of Inverloch. It is the fourth partial turtle shell to be found at this site and is by far the most complete and best preserved of them all. I had great pleasure in preparing this specimen and know that it adds vital information on this primitive group of turtles that lived in this area 126 million years ago.

I look forward to the time when the Bass Coast Preparation Group meets again and we find out how everyone has coped in these trying times. One thing is certain — there will always be more fossils to prepare.

Image: M Cleeland

Turtle shell found by Melissa Lowery

Image: Australian Age of Dinosaurs

Things Aren't Always As They Seem

By Adele Pentland

It's staggering to think that although Dinosaur Dreaming digs have been conducted since 1994, there are still new discoveries to be made. Furthermore, the identification of a single bone can shed light on an entirely new group of dinosaurs that alters our understanding, not just of the Cretaceous of Victoria, but of Australia's dinosaur fauna as a whole. After finishing a week-long stint at the Flat Rocks site in late February last year, I turned my attention to preparing the *Ferrodraco* manuscript for submission whilst perusing the Melbourne Museum collections. I figured it couldn't hurt to familiarise myself with the material I hoped to describe next, and what better place to start than NMV P252004 — the cervical (neck) vertebra discovered in 2015 by Dinosaur Dreaming volunteer Jessica Parker at the Eric the Red West site. The vertebra is quite distinct: the neural spine is low and long, the vertebra as a whole is extremely elongate (approximately five times as long as it is tall), and the articular processes or 'zygapophyses' (sticky-outy bits) are low and sweeping. In short, it's pretty weird to look at — not your normal vertebra! One would think that, since it has such a characteristic look about it, identifying what it is would be a breeze, right? That's what it would have us believe anyway…

NMV P252004 had originally been identified as a pterosaur by none other than the beloved David Pickering (at the time, the Collections Manager of Vertebrate Palaeontology) shortly after he had finished preparing the specimen. Using reference material, David concluded that the dorsoventrally short neural spine, coupled with its elongate dimensions meant that this vertebra belonged to a tapejarid pterosaur. Tapejarids are currently not known from Australia, but have been found in penecontemporaneous deposits in South America, China and (more recently) England. These pterosaurs were toothless and often relatively small (by pterosaur standards), with wingspans estimated at 1.4–2 metres.

As I explained before, during this period I was happily juggling a few different projects and had only intended to carry out preliminary observations on the pterosaur material at Melbourne Museum. This includes a rough sketch of whatever fossil I'm working on, with some of the more important features labelled to help separate the description from the interpretation, so to speak. As I was doing this, it occurred to me that pterosaur cervical vertebra have, in their ~165 million year evolutionary history (and in our 200 years of collectively studying them), proven to be procoelous and procoelous only. That is to say, at the front end of the centrum (the base of the vertebra) is concave, and the back end, or the posterior articular facet, is convex. However, NMV P252004 is amphicoelous, and both articular surfaces are concave. There's no chance that this is a taphonomic artefact either: this vertebra is about as perfectly preserved as Victorian fossils get. It's unflattened, with intact internal structure and only a tiny bit nicked off the end as a consequence of its discovery in the field.

When it dawned on me that this truly bizarre vertebra could not possibly belong to a pterosaur (the group which I remain the most familiar with), I did what any reasonable person could in that situation. I swore under my breath and then power-walked up and down the halls until I could blurt out my discovery at the nearest unsuspecting soul. As luck would have it, that person was Ruairidh Duncan, who later joined the project and created the most captivating life reconstruction of the creature that this vertebra belonged to. Unfortunately, he didn't know what to think about the identity of this vertebra, and nor did anyone else — until I was able to mention my quandary to my PhD supervisor, friend and mentor Dr Stephen Poropat.

Anyone who's had the good fortune of working with Steve either in the field or on a paper knows he's a wealth of information, not just on the sauropod dinosaurs he specialises in, but on dinosaurs in general. After I explained to him that I had hit a wall

Image: Poropat et al. 2020 Figs. 2 and 3

NMV P252004 Ventral surface after digital removal of matrix with my work on the vertebra, he started where any good researcher would: the literature. As luck would have it we were sitting in the Collections Managers' office, surrounded by Dave Pickering's collection of texts on vertebrate palaeontology, kindly donated to Melbourne Museum by his partner, Sarah Edwards. Steve picked up *The Dinosauria* and started thumbing through the section on theropods. When we came across the ornithomimosaurs, my heart skipped a beat — they looked so similar! Unfortunately, this group seemed unlikely, as they're known from the Northern Hemisphere, and all putative ornithomimosaur fossils from the Southern Hemisphere are the subject of debate. Instead, this vertebra belonged to an even rarer group of dinosaurs: the elaphrosaurs. Steve was able to make the connection after recalling that the Tanzanian theropod *Elaphrosaurus bambergi* had been suggested as an ornithomimosaur. However, *Elaphrosaurus* is in fact a member of the Ceratosauria, a group best known for chonky theropods that have been dubbed by some researchers as the Southern Hemisphere's answer to *Tyrannosaurus*. However, the weirdos within the Ceratosauria — the abelisaurids in particular — make *T. rex* look like Arnold Schwarzenegger: their arms consist of a disproportionately small nubbin of an arm with an immobile elbow, basically no wrist, and four tiny fingers jammed next to the rest of the forearm.

As we compared the anatomical features of our vertebra with the Elaphrosaurinae we gained confidence in our identification; however, at the time this group of theropods was only known from the Late Jurassic. If this was indeed a fossil vertebra of an elaphrosaur, then it extended the known temporal range of this group by almost 40 million years, as well as their known geographic range. Not bad for one bone! We ran various iterations of different phylogenetic analyses and every time NMV P252004 happily slotted within the Elaphrosaurinae next to *Elaphrosaurus*, *Limusaurus*, and another specimen from China (CCG 20011). At this stage we were confident in our identification but some confirmation from a real expert couldn't hurt either. As luck would have it, palaeontologist Dr Matt Carrano of the Smithsonian Institution was planning to visit Melbourne Museum prior to the Society of Vertebrate Palaeontology conference in Brisbane (in October last year). Carrano had published a revised osteological description of *Elaphrosaurus* in 2016 with Oliver Rauhut, so when he informed us that he too thought the vertebra belonged to an elaphrosaur, we were pretty stoked.

We announced the discovery on May 18th, coinciding with National Museum Day, and, although we hadn't named a new species and were only discussing one isolated bone, the discovery was met with a warm reception by Australian and international media outlets alike. I was blown away that it had been covered by Australian Geographic, the BBC, and had even been featured on national television. Again, not bad for one little bone. Given that the whole world (just about) was under lockdown measures to minimise the spread of COVID-19, perhaps the media was more than happy to broadcast a good news story. I also doubt that this article would have had the same impact and punch without Ruairidh's beautiful reconstruction. Although it is not included in the paper itself, I'm sure he'll be asked to prepare more palaeoart for scientific journals in the future (unless he gets side-tracked by his own research or asked to contribute to forthcoming papers). As for me, it's back to work on Australian pterosaurs, and hopefully I'll be able to revisit Eric the Red West and find evidence of tapejarids, or more elaphrosaurine material (one can't afford to be too picky).

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Elegant and Enigmatic Elaphro-saurines

By Stephen Poropat

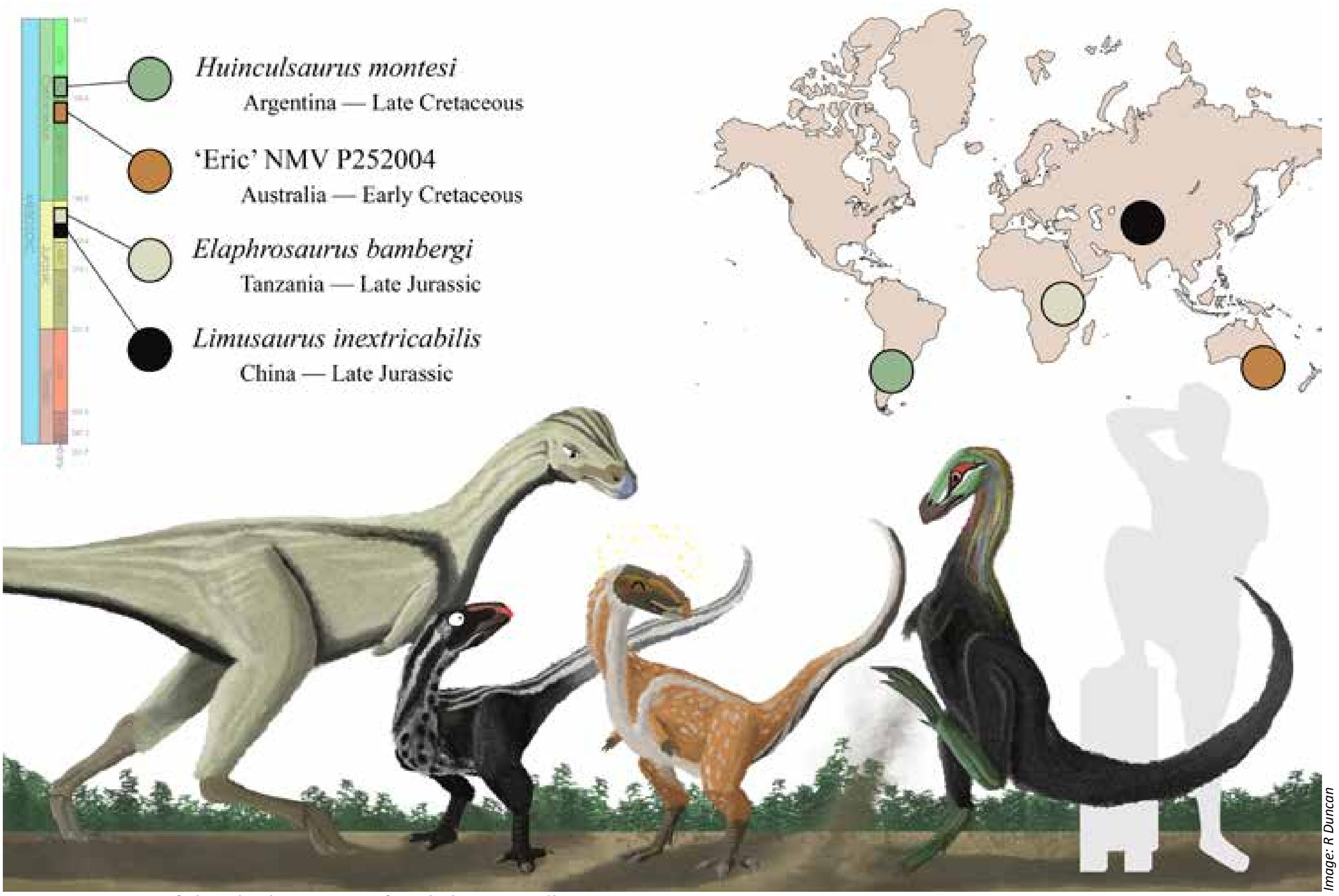
Elaphrosaurines are extremely unusual theropods. Despite the fact that palaeontologists have known about elaphrosaurines for a century (*Elaphrosaurus* was named by German palaeontologist Werner Janensch in 1920), they remain a particularly poorly-understood theropod group. In part, this is because their remains are really rare: at the end of the 20th Century, the sole skeleton (lacking the skull and hands) of *Elaphrosaurus* from the Late Jurassic of Tanzania was still the only elaphrosaurine fossil known. The recently described elaphrosaurine from Eric the Red West (ETRW) is only the fifth record of the group worldwide, provided we follow Gimli's logic that the 19 specimens of *Limusaurus* "still only count as one". More importantly, the ETRW elaphrosaurine vertebra constitutes just the second Cretaceous record of the entire group worldwide.

When *Elaphrosaurus* was fully described by Werner Janensch in 1925, it was lumped in with 'coelurosaurs', a group which was, at the time, essentially a grab-bag for most theropods less than 6 metres long. Coelurosauria is now a much more exclusive club, with a substantially different set of constituents, including all modern birds, *Velociraptor*, and *Tyrannosaurus*. In 1928, Baron Franz Nopcsa made a case for *Elaphrosaurus*' inclusion in the group Ornithomimidae — the 'bird mimics', commonly known as ostrich dinosaurs (which were, and are, considered to be coelurosaurs). For decades, this was tentatively accepted by most palaeontologists and seemingly reinforced in the early 1980s by Peter Galton (Wendy's favourite). However, in the late 1980s, Greg Paul suggested that *Elaphrosaurus* was not an ornithomimosaur, or even a coelurosaur: instead he argued that it was a relative of more 'primitive' theropods, like *Coelophysis* and *Dilophosaurus* (of Jurassic Park fame). Then, in the 1990s, Tom Holtz determined that *Elaphrosaurus* was more likely to be a ceratosaur — closely related to *Ceratosaurus* and the short-faced, stumpy-armed abelisaurids. Even with more elaphrosaurine specimens to play with, *Elaphrosaurus* and its kin have been consistently classified within Ceratosauria since the 1990s; more recent discoveries have only reinforced Holtz's hypothesis (Rauhut and Carrano, 2016).

One of the greatest advances in understanding elaphrosaurines was the discovery of multiple nearly complete skeletons, representing several distinct growth stages, of the Late Jurassic *Limusaurus* from China (Xu *et al*, 2009). These skeletons show that elaphrosaurines would have superficially looked very much like ornithomimosaurs: they had long necks, lightly-built bodies, powerful hind legs and long tails. In detail, however, there were some striking differences: *Limusaurus* had shortened arms, four fingered-hands, and reduced hand claws (like all ceratosaurs), whereas ornithomimosaurs had elongate forelimbs, three-fingered hands, and enlarged, weakly-curved claws.

The biggest surprise about *Limusaurus* was the structure of its skull (Wang *et al*, 2017a, 2017b). Adults had toothless beaks, just like all but the most 'primitive' ornithomimosaurs, such as *Pelecanimimus* and *Hexing* (pronounced hee-shing: it's not a Harry Potter manoeuvre). Conversely, juvenile *Limusaurus* still had teeth — and fairly prominent teeth at that! This suggests that *Limusaurus* — and, by extension, perhaps all elaphrosaurines — underwent a pretty substantial dietary shift during their life history. As youngsters they preferred to eat small reptiles and mammals (sorry, Tom Rich), whereas as adults they appear to have adopted a mostly plant-based diet (sorry, Anne-Marie Tosolini); this is borne out by the fact that adult *Limusaurus* had gastroliths (stomach stones) that presumably aided in plant pulverisation, whereas juveniles did not. Of course, in Australia today there is still one animal that has teeth in its youth that are lost and replaced with a beak as it grows: the platypus (your elderly relatives do not count).

2020 was an important year for elaphrosaurines, and not just because it s *Elaphrosaurus*' centennial. In February, the announcement of *Huinculsaurus* from Argentina demonstrated that elaphrosaurines survived beyond the end of the Jurassic, into the Cretaceous (Baiano *et al*, 2020). Although the ETRW elaphrosaurine is slightly older than *Huinculsaurus*, it is no less important: that it was living near the South Pole (~76°S) suggests that elaphrosaurines were capable of tolerating cool temperatures and long periods of darkness. This implies that we can also expect to see elaphrosaurines popping up across a far broader geographic range in future. Moreover, given that *Huinculsaurus* is even younger (geologically) than the ETRW elaphrosaurine, we might reasonably expect to find elaphrosaurines at Lightning Ridge and in Winton, since the rocks in both places are about the same age as those that produced *Huinculsaurus*.



Reconstruction of the elaphrosaurine family by Ruairidh Duncan

Hopefully, when we get back to ETRW, we'll find more evidence of the elegant enigmas that are elaphrosaurine theropods. That said, we might even find more evidence at Melbourne Museum — who knows what else remains to be identified in the collection?

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Image: L Nink

Reconstructing Eric the Elaphrosaurine

By Ruairidh Duncan

As something of a newcomer to the world of Victorian palaeontology, I am forever amazed at this part of the world and its ability to surprise us with new material. 'New' of course is a relative term, as these specimens are invariably well over 110 million years old, but I digress. This year we announced the discovery of Australia's first elaphrosaurine, a rare gracile theropod group known from precious few localities around the world. Being involved in this discovery — the first of a new type of dinosaur in the country — was a rare privilege in itself, and the fact that this was also my first scientific paper made it all the better. The majority of the descriptive and comparative work on this specimen was performed by my excellent coauthors Adele Pentland and Stephen Poropat. I was not involved in the decisive moment of discovery, where the identity of our bone changed from a pterosaur to a weird noodly theropod. In fact, I came into the Victorian elaphrosaur project fairly late, and my contribution was primarily the preparation of our 3D model from the synchrotron data. This took a great deal of time but, with a bit of perseverance, I was able to gradually, slice-by-slice, remove the obscuring matrix from the underside of our all-important vertebra, thereby allowing us to assign further characters to this specimen and to make our assessment of the fossil as belonging to our first Australian elaphrosaur all but certain.

Months pass, the world goes topsy-turvy, and lockdown begins. I decided to take some of this time and put it towards developing my digital art. Thereby creating my very own Frankenstein, the Fionnaghual; a re-imagining of an animal I designed when I was six. It was designed how most six-year-olds design things: with no concern whatsoever for mechanics or physics of any kind. As such, she's a hodgepodge composed of the head of an *Iguanodon* (my favourite dinosaur), the forelegs and wings of a dragon (Spyro the Dragon, if we're getting into the minutiae of it), the hind limbs of a *Velociraptor* and the tail of a Galápagos land iguana. Naturally, I thought I could improve on that and so I gave her the plumage and wings of a snowy owl and the tail spines of a *Stegosaurus*. I look forward to seeing where I'm at with this design in another 19 years. I guarantee that physics and aerodynamics will still exist and that the likelihood of such a creature taking flight will still be, at best, dubious.

One thing that I am sure is apparent from that artwork however, is that I am in no way an expert. I am entirely self-taught, save for lessons learned through the magic of the internet. So, when Steve Poropat, the enthusiastic and endlessly encouraging fellow that he is, suggested on the basis of the Fionnaghual that I create some artwork to show off our new discovery here in Victoria, I was more than a little hesitant. This was just after the announcement of *Huinculsaurus* from South America, which (as well as being younger than our specimen and beating us to the punch of having the first elaphrosaurine recorded from the Cretaceous) had been later accompanied by a spectacular reconstruction by the peerless Gabriel Ugueto, who is without a doubt one of the most talented palaeoartists in the world today. Terrified of direct comparisons, I at first rejected the idea, but once again I was pulled from my comfort zone and convinced otherwise and now, having done so, I am immensely glad I did.

Eric the Elaphrosaurine, my not-very-imaginative name for the Eric the Red West-based subject of my painting (and one which some news sites ran with unchallenged,

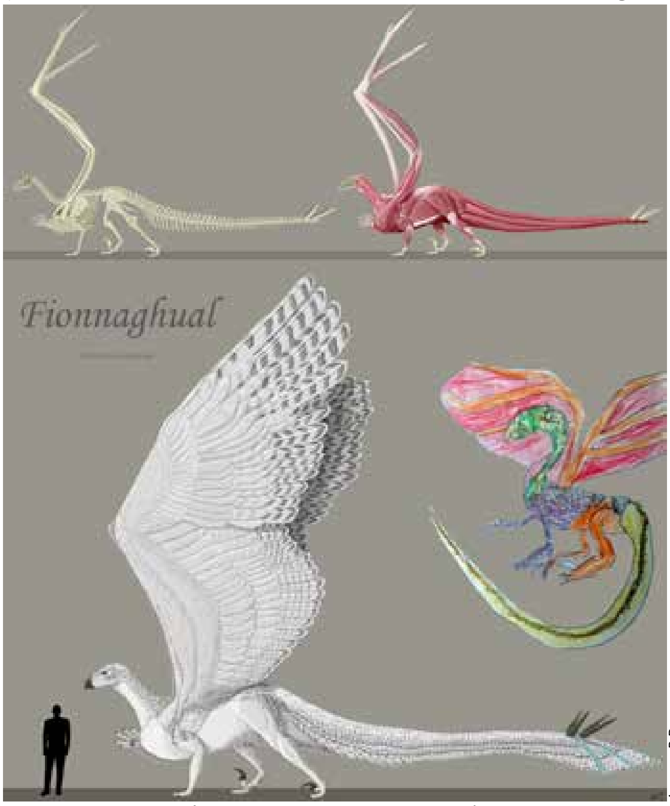


Image: R Duncan

*The Fionnaghual (*Ornithodraco berkeliensis*) and its coloured pencil inspiration*

Image: R Duncan

Cryptid celebrity Nessie, making her appearance in the Victorian Cretaceous

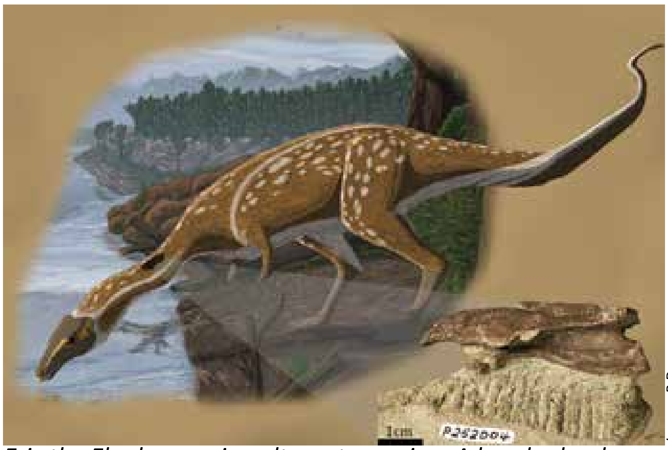
much to my amusement), is the first artwork I've made since I was in high school with the intent of showing to other people. What follows is a rough detailing of the process of its creation, such that it is. One of the blessings and curses that comes with restoring animals like elaphrosaurs is the dearth of information available on them, with only four preexisting valid referrals to the group. Consider our specimen: a single neck vertebra which is not broadly informative of the animal's gross morphology beyond being extremely similar to the vertebrae of *Elaphrosaurus bambergi*, itself an incomplete animal (known from a partial vertebral column, a pelvic girdle, a left hindlimb and a partial forelimb). As a result, there is a degree of speculation required which can be somewhat freeing, but it must be informed by as much well-reasoned lines of evidence as possible. For this, we first need to look at *Elaphrosaurus*' much more complete cousin, *Limusaurus inextricabilis*. The published specimens of *Limusaurus* informed many of the decisions I made with this painting. It is because of this taxon, for example, that I chose to give Eric a beak and the stubby, four-fingered hands with reduced first and fourth digits. By contrast, the decision to have Eric wrapped in a fluffy covering of monofilaments was based on a great deal more inference. This choice was based on studies which suggest that some simple filamentous integument might be ancestral to all Avemetatarsalians (the group which includes the last common ancestor of all dinosaurs and pterosaurs), although this issue is nothing if not hotly contested. The record for integumentary coverings in ceratosaurs (the group which includes elaphrosaurines) is sparse, with only *Carnotaurus* — a highly derived member of the group — preserving evidence of its skin covering in the fossil record. In the case of this late surviving ceratosaur, portions of the head, neck, shoulders, torso and tail are preserved, which show that it was covered in non-overlapping tuberculate scales. However, as *Carnotaurus* is a late evolving and highly specialised member of the ceratosaur lineage, I considered it unlikely that it represented the condition seen in the fairly 'primitive' elaphrosaurines. Thus, Eric is fluffy.

Working first from a concept sketch provided by Steve Poropat, I began my work. The basic outline would be one that tried to be as conservative in its speculative anatomy as possible. For this reason, we kept the jaws shut, as the toothless nature of this animal was suspected and supported by *Limusaurus*, but not able to be confirmed without first finding a skull in Australia. Furthermore, as Eric would have been a small-bodied animal living in what was a vast Austro-Antarctic forest, I reasoned that we would expect to see a colouration which reflected that. The integument of Eric was inspired by that of arctic sanderlings, spotted quolls and fallow deer, which all have independently evolved dark orange integumentary coverings, a light underside (known as countershading) and — in the case of the quoll and the deer — distinctive white spots as a means of breaking up their silhouette in a wooded environment. Seeing as elaphrosaurs might have transitioned from toothy, mostly predatory juveniles to mostly herbivorous, beaked adults, the carnivorous quoll and herbivorous deer seemed a good middle ground on which to base Eric's spotted integument. These two animals show a convergence seemingly based on environmental conditions, rather than one based on their means of acquiring food, possibly indicating that such a colouration works both for predation and for predator evasion. As elaphrosaurines might be doing both at various points in their life, it seemed a good model from which to work.

When it came to the process of painting Eric, the first stage was setting out the scene. I drew an extremely rough sketch of my elaphrosaur and the environment in which I wanted it to appear. In this case, the shores of a large river system such as that which characterises almost all of the Victorian Cretaceous localities (Collage 1–2). I next began ironing out the anatomy, ensuring the proportions of the legs and vertebral column were

Image: R Duncan

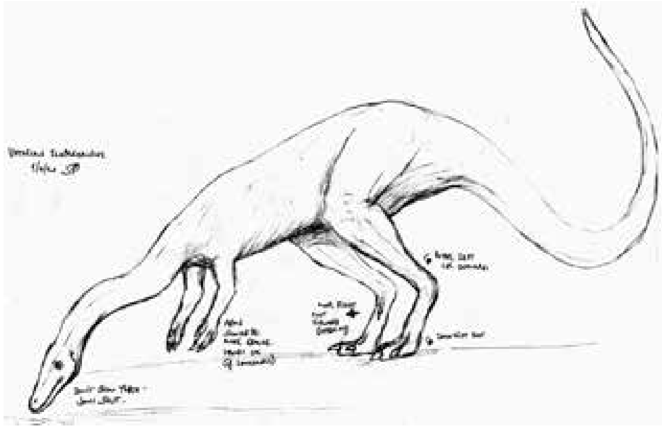
Ornithocheirid pterosaurs, so far only known at ETRW from undescribed teeth



Eric the Elaphrosaurine alternate version. A handy-dandy guide of where our tiny neck vertebra would have been located in the animal itself.

reasonably in line with those seen in *Elaphrosaurus* and *Limusaurus* (Collage 3–4). After that comes the colour selection and detail work. I probably should have left this section until later on in the process, but as Eric is the subject and the star of the show, I wanted to devote as much time as possible to getting his appearance right (Collage 5–8). Throughout this process, I was also sharing my work-in-progress shots with my coauthors and updating features as per their suggestions. I also decided around this point that I was going to break with my conservative approach and indulge in a spot of wild speculation. It's because of this that I gave Eric a degree of head ornamentation, with brightly coloured skin around his eyes and two small, raised projections along the top of his snout. These features are intended to depict a possible sexual selection structure, which might have evolved in a lineage almost fifty million years removed from the only elaphrosaurine skulls we have of *Limusaurus*, particularly as birds, their closest living relatives, have developed countless examples of dramatic sexual selection structures — the classic example being the peacock's tail. Furthermore, head ornamentations are kind of a big thing in ceratosaurs, with prominent cranial display structures appearing in closely related

*A Mesozoic mammal (*Bishops *cf.* B. whitmorei*).*



Steve Poropat's Victorian elaphrosaurine concept sketch

dinosaurs older than Eric (such as *Ceratosaurus*) and younger (such as *Carnotaurus*), so I considered it reasonable speculation that some ornamentation might develop (although I'll happily be proven wrong if it means we find a skull here in Victoria). Following the detailing of Eric, the process then becomes one of slowly building up the setting for the painting. This is helped immensely by the medium of digital art as it enables me to separate the foreground, midground, subject and background into distinct layers which can be toggled on and off. This enabled me to isolate and detail areas as needed without concern for the effect of those changes on the rest of the painting. I worked from the background forward, slowly layering in detail over the skeleton of my setting and trying to keep the depicted plant life consistent with what is known from the Eumeralla Formation (Collage 8–12). It was also around this point that I started adding in extra figures. If you look closely, you'll be able to spot:

1. a small mammal (based on a jawbone assigned to *Bishops* cf. *B. whitmorei* from the same site as Eric);
2. ornithocheirid pterosaurs (known only from undescribed teeth); and
3. three *Leaellynasaura* (not yet described from this site — but watch this space!).

All of these additions are based on direct fossil evidence from the Eric the Red West site. The only exception is Nessie (the Loch Ness monster), who has been an often-hidden staple of my paintings for the past 10 years and makes her appearance here too (albeit not as a plesiosaur). Best of luck finding her. The final stage in the process is to add in lighting effects and shadows (Collage 11–12). These go a long way towards polishing the work off and (in my opinion) give significantly more depth and life to what is otherwise a fairly flat image. An additional benefit of using digital painting as a medium is that I was easily able to produce two versions of the same image: the first (as seen on the front cover of this report), showing the shadow of the foreground trees on Eric's back and using all of the available canvas, and the second utilising my 3D model and the togglable nature of the foreground layers to show the approximate location of our fossil in our new elaphrosaur.

My artwork has a long way to go and I have a lot of improvements still to make in my technique (Peter Trusler I am not) but I'm glad I was encouraged to produce this painting. Surreal as it may be to see my name on a scientific paper, it pales in comparison to having my primary school friends from the UK contact me after seeing my artwork on the BBC home page. I hope to continue working on Victoria's ever-expanding dinosaur fauna for quite some time yet and to develop my skills as a palaeoartist further. I hope too that we can return to digging at Eric the Red West soon and, if we're very, very lucky, that we find more of Eric's lost brethren whilst we're there.

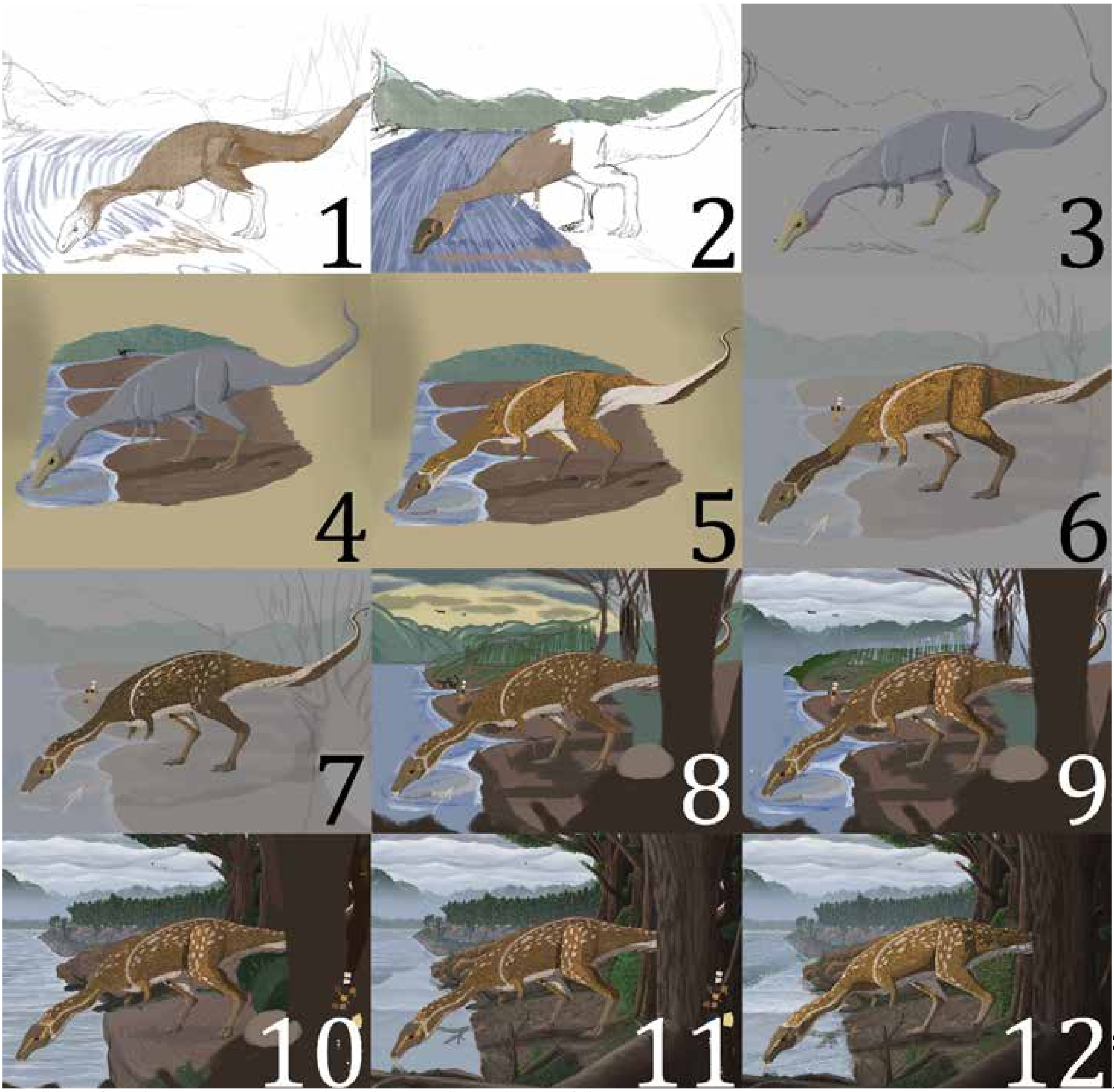


Image: R Duncan

A collage of work-in-progress screenshots showing the evolution of the painting

Image courtesy of B Wagstaff

A Tale of Two Palynologists, Both of Whom Are Me

By Barbara Wagstaff

Most palynologists fall into one of two camps. Firstly, there are the Quaternary palynologists who have the age of their research sites determined by absolute dating techniques. Therefore, their primary use of palynology is to reconstruct how vegetation has changed and relate it to climate. Such palynologists usually come from a geographical or botanical background. Secondly, there are those that work in the pre-Quaternary where dating is the main aim of the game. Such palynologists usually have a geological background. But I have worked in both types of research. In fact, the first palynology project I did was on a Pleistocene site. This meant that while busy looking at the slides collected from the coast in Victoria to date the vertebrate fossil sites, the Quaternary palynology side to my personality was humming in the background. I could not help myself and rather than just looking for age indicators I undertook counts of the pollen grains and spores to possibly use later to do some research into the vegetation. I thought it would have some value as surely placing the animals in a landscape was relevant. While counting I started to get the feeling that I sometimes get in the back of my brain that things were not the same through time. I got to the point when I could actually tell the age of the sites in Gippsland even before I saw age indicators, just on the abundances of the pollen grains of the woody plants that made up the tree or shrub layer of the vegetation. You must remember that this is well before flowering plants have come to any kind of dominance in the vegetation and that gymnosperms ruled the forest.

To illustrate what I mean let us take this idea of changes in the vegetation through time to two specific sites. The Honey Locality(Figure 1) and the Eagles Nest area (Figure 2) are near each other geographically but separated by a massive fault. Palynology has shown that the Honey Locality is older (late Barremian) and the Eagles Nest area is slightly younger (Early Aptian). Therefore, you can consider that the sites sit either side of the Barremian/Aptian boundary at 126.3 Ma. Lithologically, there is nothing to distinguish them. You would not be able to look at them on the ground

Image: B Wagstaff

Figure 1. The rock platform Honey Locality near the Caves, Gippsland.

and make any comment about how they relate to each other in time or say that something has changed in the environment over that time. At both sites, the finer grained sediments (the ones that I use) form a continuing sequence of siltstone and mudstone across the rock platforms deposited in a low energy channel fill or floodplain environment. The secret lies in the plants and more specifically in the abundances of the woody plants. I have summarized the woody plant data as a histogram that shows their average values at the two sites (Figure 3). I also put in the flowering plant pollen (angiosperm) just for interest. The startling fact is that at the younger site (Eagles Nest area) the pollen grains that relate to the modern day Podocarpaceae (plum pines) are much more abundant than in the older site, and there is a decrease in Cheirolepidaceae (an extinct group of conifers). Whatever caused the abundances of the forest trees and shrubs to alter also allowed the first flowering plants to migrate

Image: B Wagstaff

Figure 2. Rock platform Eagles Nest area, Gippsland with Mike Cleeland for scale.

into the Gippsland Basin part of the rift valley. We know that the primary drivers of vegetation are temperature and rainfall. What do we know about the affinities of the fossil pollen and their modern relatives? This is where Quaternary palynologists have it easier, as the fossil pollen can be related to modern plants that have known environmental tolerances. But 126 million years ago, is a long stretch. We can however make broad assumptions and the increase in abundance of pollen that has an affinity with the Podocarpaceae suggests an increase in rainfall. The Podocarpaceae are a family of gymnosperms that occurred in the fossil record across Gondwana and still exist today. Podocarpaceae inhabit high rainfall regions, including Australia, where they occur in cool temperate rainforests in Victoria and Tasmania and warmer rainforests of NSW and Queensland. The decrease in Cheirolepidaceae (an extinct group of conifers) in the Eagles Nest area samples confirms this as we know from the fossil record that they tend to be higher in drier regions.

So why would I bother with this? Surely the ages of the sites are the key take home message that the palynology set out to provide. But the fact that the vegetation and therefore the climate changed must have had implications for the animals. It is possible to think of numerous environmental factors that would have changed in the younger sites in Gippsland, including increased and more consistent rainfall leading to increased and more consistent streamflow. Higher moisture levels would result in denser forest vegetation and changes in fire regimes (yes there were fires in the Cretaceous). I have not even considered the understory vegetation in this diagram (Figure 3) but it also has significant changes. Knowing the environment, the animals lived in and how it changed through time not only places them within a vegetated landscape and provides insight into the climate, but may also be a key to why the vertebrate fossil assemblages themselves change.

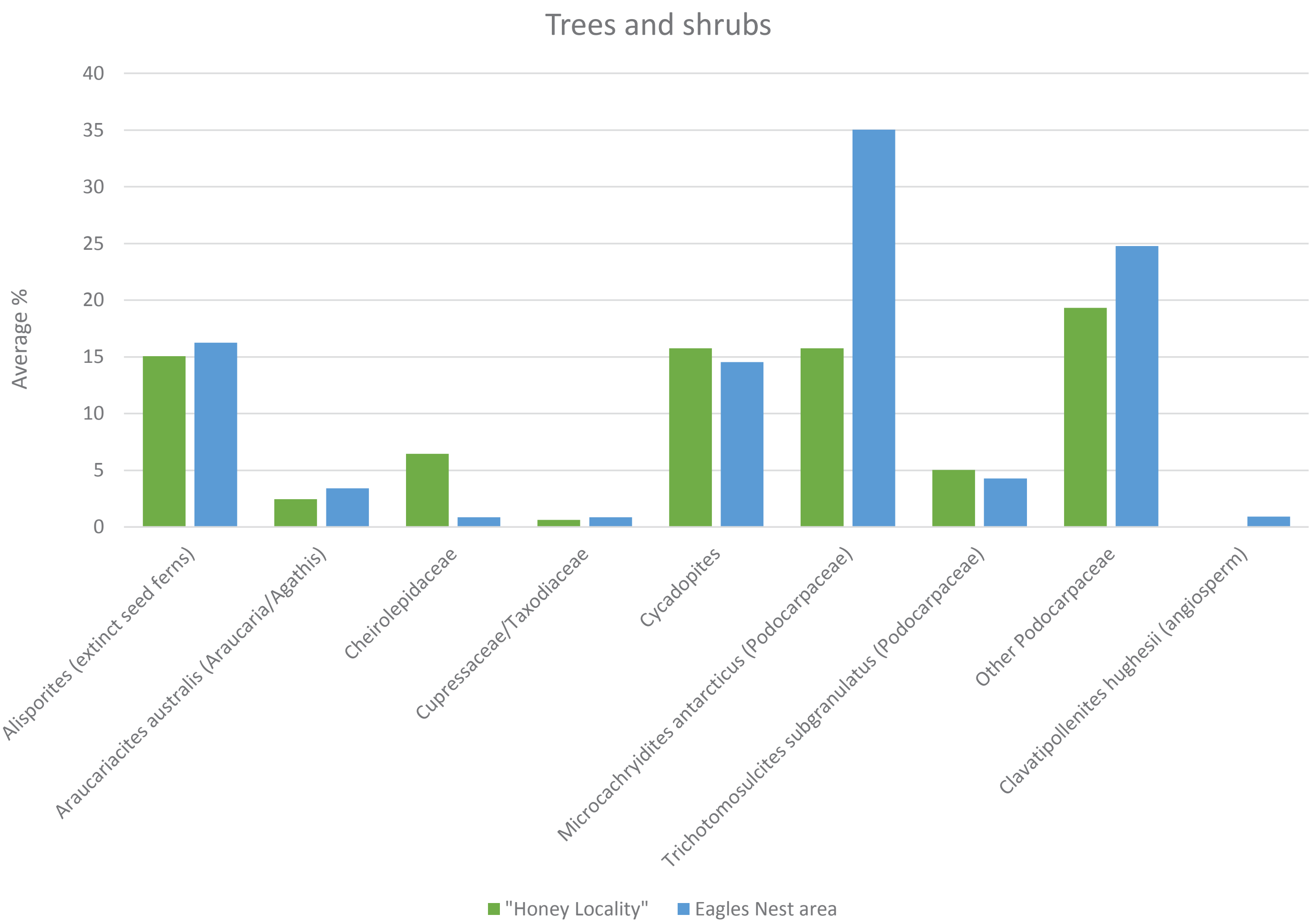


Image: B Wagstaff

Figure 3. Histograms showing the percentage of tree and shrub pollen forming the forest overstory at the Honey Locality and the Eagles Nest area sites.

Image courtesy of P Vickers-Rich

Bunurong Polar Dinosaur Museum

By Pat Vickers-Rich

For a number of years, a small Museum has been in place at the RACV Inverloch Resort, not far from Eagles Nest where the first dinosaur ever found in Australia was discovered by William Hamilton Ferguson in 1903 just a bit to the west of the Resort. So, with the emphasis of RACV on travel and discovery, it seems most appropriate to have in place a small, regional Museum and Discovery Centre in this spot. The Resort has already in place on the Inverloch property a stunning Bunurong Discovery Trail that nicely links with the dinosaurs and ancient biota which once graced this Bunurong land. Palaeontologists are working with the Bunurong people to expand this small exhibition into a proper Discovery Centre on the RACV property showcasing the long history of this land — a true educational asset for tourism, school groups and locals.

For a number of years there have been plans to expand this Expo and construct a purpose-built structure that could house a much larger display (which already exists and could be immediately installed if the museum could be built, hopefully on RACV land). Not only do the specimens exist, so does the furniture, the equipment to fully outfit a preparation laboratory, an education or small lecture classroom and even a small Virtual Reality (VR) room where the dinosaurs (and their friends) would come alive. The IT already exists for this as do a number of documentaries that could be rotated and added to over time, including one involving our patron Sir David Attenborough.

Image: P Vickers-Rich

Dinosaur displays at the RACV Inverloch Resort

Image: P Vickers-Rich

Fossils, books and toys at the RACV Inverloch Resort

In addition, a dinosaur library is already in hand that could be used not only by school kids but also the general public and in particular tourists staying at the RACV Inverloch Resort. Local volunteers are on tap to maintain this facility as well as run the preparation laboratory where preparation of new discoveries being made even now could take place, and tourists, students and locals could be scheduled to join this activity. There is a real opportunity for the researchers and locals who work on this Dinosaur Dreaming project, who constantly explore the shore platforms, to provide lectures for residents and visitors from outside, providing an ongoing series of activities that would attract a wide audience to the region and especially to the RACV Inverloch Resort.

Ecoliv, a local group which builds Eco-friendly and sustainable buildings has generously come up with a design for this Bunurong Polar Dinosaur Museum (Discovery) Centre, and a local donor has offered, for free, all of the furniture, prep lab outfitting, specimens, information panels, library, documentaries, and VR database. All that is needed is the land and a small amount of funding to construct the building. And with that, the fun can begin.

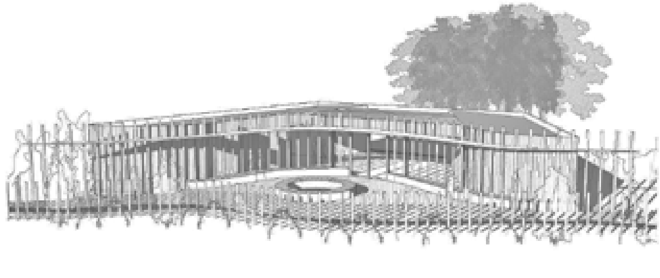


Image courtesy of P Vickers-Rich

Ecoliv's design for the Dinosaur Museum

Image: J South

Bass Coast Dinosaur Trail

By Mike Cleeland

Guess what? We're going to have a trail!

The Bass Coast Dinosaurs Trail proposal seeks to construct a series of artworks at selected sites along the coast, showing the actual appearance of the dinosaurs and other tetrapods that lived in these places around 125 million years ago.

The main aim is to educate residents and visitors about the diversity of the polar dinosaur fauna in the Bass Coast region.

Drawing on the countless hours of digging, researching, prospecting, preparing and breaking rocks in the hot sun and cold wind since Ferguson's first discovery in 1903, the trail hopes to showcase the results of this effort to the wider community.

The work of the 1978–79 prospecting team including Tim Flannery, John Long and Rob Glenie, the Dinosaur Dreaming dig team led by Lesley Kool and the research team led by Tom Rich and Pat Vickers-Rich will be brought to the attention of Australia and the world.

The Bass Coast Trail will complement the Winton experience in Queensland and offer a Polar Dinosaur Discovery Trail in the southern state of Victoria.

The Bass Coast Shire Council has approved funding of $250,000 to develop a Master Plan for the trail, which will determine the fine details, such as the precise location of the dinosaurs and other tetrapods, the way in which they are to be represented, community consultation and selection of people to carry out the construction phase.

Further funding will be sought by the Bass Coast Council for construction of the trail, which is expected to take place over the next few years.

Stay tuned for next year's exciting episode, in which we talk about incorporating Victoria's Cretaceous Dinosaurs into a Global Geopark!

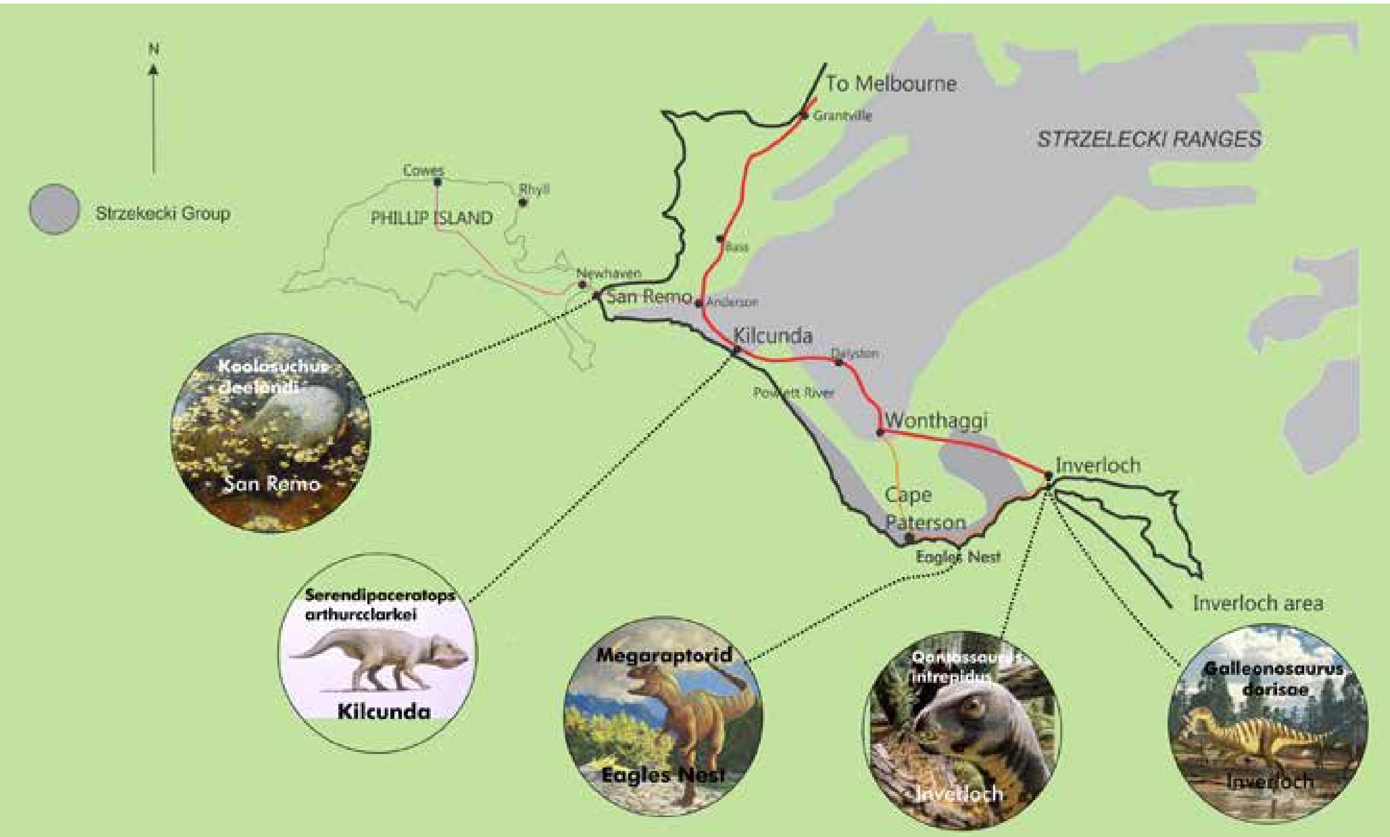


Image: L Kool, with artwork by P Trusler, A Plant and J Kuether

Proposed Bass Coast Dinosaur Discovery Trail

Image courtesy of M Kundrát

Fossil Feathers

By Martin Kundrát

Since the 1970s, a saga has been written about systematic explorations carried out in the southeastern corner of Australia by a team of determined enthusiasts led by Dr. Thomas Rich and his colleagues from Museums Victoria. Seasonal diggings at Dinosaur Cove and Flat Rocks became legendary over decades. Searching for fossils in hard rocks only when the Southern Ocean tides regressed from Cretaceous beds flavoured this exploration with adventure worthy of Australian exotics. This is how the world heard about the first polar dinosaur from the southern hemisphere. This is how I learnt about the first Australian dinosaurs.

Such thoughts ran through my head when my plane was about to land in Melbourne in 2014. I was on my way to the Australian Synchrotron to scan some of the fossils discovered on this continent. There was something far more important to do than that. I was supposed to meet Dr. Rich for the first time in my life. This opportunity was catalysed by two small feathers. Not common modern feathers but feathers that had turned into stone. Some palaeontologists knew that two fossilized feathers were discovered in Koonwarra in 1960s. However, only a few dedicated people were aware of a much larger set of feathers discovered in Koonwarra more recently.

Before I arrived in Melbourne, I had already worked for some time on unusual Chinese fossils from Liaoning which wrapped dinosaurs into plumage. It was a quality of preservation that had caught my attention to re-study the two fossil feathers from Koonwarra, first described by John A. Talent and his colleagues before I was born. Well, Dr. Thomas Rich had another kind of surprise for me, the collection of ten(!) specimens of fossilized feathers from Koonwarra, each having a specific shape. Such a rare moment usually happens once in professional career. It has been some time since that moment but some things never change. It has been a privilege for me to accept the offer by Dr. Rich and to analyse such a unique collection that was assembled over the last decades. I do not know all the names of the people who found these particular fossils but I wish to say that the study published this year would never appear without their contribution.

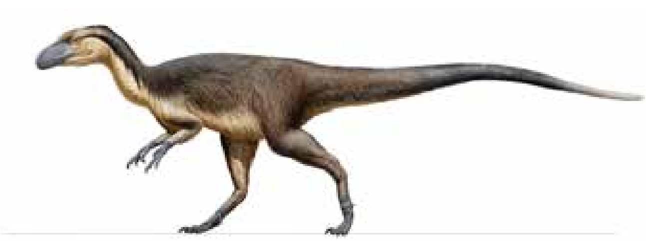


Image: P Trusler

Peter Trusler's reconstruction of a feathered polar dinosaur

Image: Museums Victoria

Dinosaur protofeather (NMV P160550)

Carbonized remains of the Koonwarra feathers began to tell a story soon after I looked at them under different microscopes. First, I realized that the collection includes a rare type of protofeather (NMV P160550) characterized by a short calamus, followed by a short rachis with a clump of parallel branches (barbs) stemming from it. Undulated branches suggest they were flexible in life. I did not observe clear evidence that they form some secondary branches (barbules). I had found similar protofeather units, sometimes much longer, in some Chinese theropod dinosaurs (such as therizinosauroids, dromaeosaurids and troodontids) but also described from integumentary appendages imprinted from the belly of a resting ?tetanuran or ?neoceratosaurian from the famous Hitchcock´s collections in Amherst, USA (Kundrát 2004).

Partly similar to this was another specimen (NMV P250594) that looks at first sight rather as a cluster of disintegrated overlapping fibres. But this may be just an early impression. With being more patient one may identify a bunch of variably folded 12 barbs joined into a short rachis. My opinion is that miniature size combined with the presence of barbules together with other mentioned characteristics gives this specimen the identity of a down feather. What? Down feather in a polar environment? This is a moment when one solved puzzle creates another one to be solved. There is still something neat about this down. Periodically repeated darker regions make the barb and barbule filaments striated, and the whole down thus having cryptic coloration. A juvenile dinosaur could profit from the camouflaging and heat-keeping plumage to become 'invisible' and protected.

The down feather story goes on. The dark striations took my full attention and therefore I decided to look at them using stereo electron microscope which showed up to be a great idea. The dark stripes turned out to consist of assemblages of miniature objects. Their uniform alignment and size proportions, and absence in alternating light stripes gives a solid evidence to me to interpret them as remains of colour-bearing organelles. We call them eumelanosomes due to their elongated shape and know that these produce greyish to black colours in feathers of modern birds.

The most abundant type among fossil feathers from Koonwarra was vaned (pennaceous) feathers (such as NMV P162963, P186979, P165474, P32192). All but one belonged to body (contour) feathers. The vanes were formed by barbs with long barbules making such feather fluffy and trapping air between overlapping vanes. The contour feather was adapted to effective insulation and display that was probably utilized in sexual dimorphism and other behavioural activities. Some parts of these feathers were populated more by eumelanosomes than others. In some cases were eumelanosomes packed closely, reminding of arrangements in modern feathers with a certain degree of iridescence.

The one remaining feather is the most striking specimen (NMV P26059). There is no doubt this feather came from a wing and quite likely from an active flier. I assume it belonged to a small primitive bird (avialan dinosaur). What has led me to such conclusion? The feather had a massive calamus for firm attachment, a straight broad rachis strong enough to withstand


Image: Museums Victoria

Avialan flight feather (NMV P26059)


Image: Museums Victoria

Early bird feather with colour patterning (NMV P165474)

bending forces, asymmetric vanes typical in all modern actively flying birds, and finally the presence of tertiary branches (barbicels) that zipped up neighbouring barbules and barbs to form compact and flexible vanes. Particularly, the last structures made me certain that the preservation of these fossil feathers is one of the best of those discovered so far. This gives added value to the specimens and makes them a rich source of information that may be understood even better with advent of new analytical tools in the near future.

Well, what to say at the end? Perhaps the best part of this story. There is no doubt about the scientific importance of the fossil feathers from Koonwarra for our understanding of the evolutionary adaptations, morphological and functional, of dinosaur feathers in extreme climatic biotopes. In my opinion, there is an even more important message to be understood from these findings. That is, the need of further large-scale exploration of the Australian dinosaur feather locality. Koonwarra has not said its last word. The Koonwarra Polar Biota is still waiting for its Day D to finish the story that has just begun.

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Image D Hocking

Simona's Temno-spondyl Skull

By Tim Ziegler

The presence of giant, aquatic amphibians known as temnospondyls is one of the unique aspects of Victoria's polar Cretaceous fauna. The first Victorian temnospondyl fossil was found in 1978, and initially defied classification. Continued research and the steady accumulation of new finds led to the naming of *Koolasuchus cleelandi* Warren, Rich and Vickers-Rich 1997, a large (3-4 metre long) taxon belonging to the Chigutisauridae, and still the latest known temnospondyl in the geological record. The holotype specimen of *K. cleelandi* comprises a pair of associated lower jaws, and a small number of skull and girdle elements have been referred to the genus. However, a more comprehensive taxonomic assessment requires specimens including the same elements as the holotype as well as additional bones. Such partial skeletons have thus far been elusive for *Koolasuchus*, with other temnospondyl fossils found only in isolation.

Image: T Ziegler

Simona's skull as collected, still largely encased in matrix

Happily, we can report this was upended on 19 April 2020. Simona Grippi discovered the partial skull of a large temnospondyl, exposed in a boulder at a steep-sided cove west of the Punchbowl, San Remo. The recovery of the skull took place on 7 May, an auspicious celebration of the 117th anniversary of the discovery of the Cape Paterson Claw, Australia's first known dinosaur bone, by William Ferguson in 1903. The skull was extracted from a large boulder with circular saw and hand tools, and winched to safety in a day-long operation. Chris Cudmore generously provided clifftop property access, allowing us to enter the cove directly rather than via a long walk across the shore platform.

A preliminary anatomical assessment is given here, along with observations on sedimentology and taphonomy. The specimen comprises a partly eroded cranium with a preserved anteroposterior length of around 400 millimetres, as well as a right lower jaw, and further unidentified elements. If Simona's skull is ultimately referable to *Koolasuchus cleelandi*, it will dramatically increase the potential for formally assigning cranial material to the taxon, including other partial skull fragments already known. Alternately, it may be a second species of temnospondyl in the Victorian Cretaceous.

The left-hand side of the skull, from the anterior teeth back to a rearward projecting horn, formed from the tabular bone. The lateral surface of the skull appears to be complete, from the dorsal skull roof to the screw-like quadrate and quadratojugal, which form the articulation for the lower jaw. The left side of the palate, still largely under matrix, can be seen in cross-section along the boulder. Two shaft-like bones may be ossified branchial elements, which form throat and gill structures. These are in matrix above the skull roof, and will need to be removed before the skull's dorsal surface can be fully prepared.

A midline palatal bone, the parasphenoid, remains articulated with the left-side skull fragment and includes the posteriorly projecting cultriform process. The right-hand side of the skull roof is almost completely missing, with the exception of a partial palate and upper jaw. The right pterygoid and ectopterygoid are exposed on the surface of the boulder, along with fragments of the premaxilla and maxilla. These are in correct anatomical position, suggesting the skull was reasonably complete at the time of burial, and eroded by modern exposure in the cove. Based on the absence of bone cross-section in the rear of the boulder, the skull's occipital condyles and braincase may have become detached before burial and not preserved.

The skull also includes a number of in situ teeth, which are identifiable in cross-section by their eponymous labyrinthine enamel structure. In the upper jaws, the preserved dentition includes a row of small, closely spaced teeth in the right premaxilla, a twin row of teeth just left of the midline and several large tusks projecting from the palate. Temnospondyl teeth are cemented to the jaw and palate by a cementum overgrowth rather than rooted in sockets. At least one incompletely developed replacement tooth may be evident in the skull, laying flat against the left vomer.

The right lower jaw is rotated laterally, exhibiting similar mediolateral compression as in the holotype. The visible surface of the lower jaw is deeply weathered and friable, but preliminary exploration showed it preserves a series of small, worn teeth in shallow pits. Careful preparation of the jaw will be critical to taxonomic analysis, due to the potential for comparison with the *Koolasuchus* holotype.

Most temnospondyl fossils in Victoria are found in a strongly cemented conglomerate of pebbles and gravel, suggesting deposition in higher-energy water conditions rather than the fossil-rich deposits at Flat Rocks or Eric the Red West. By contrast, the skull is preserved in a massive, unbedded sandstone. Where the interface with the sediment is preserved, the skull is partly impressed into clay or resting on a coarse gravel. This suggests the carcass was deposited upside-down, on a relatively stable channel bed, and was rapidly buried by fluvial sands soon after.

Thanks perhaps to a quick burial, the dorsal ornament of the skull is well-preserved. Initial preparation has uncovered pitted reticulate or rosette-shaped regions, and linear ridge-and-groove patterns. Channels in the skull roof indicate the position of a lateral line system

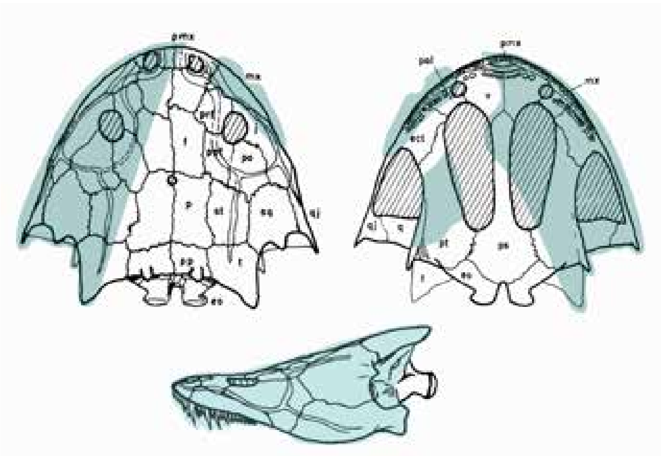

Image: T Ziegler, Modified from Sengupta (1995) Figs 5 and 7.

The skull of a Triassic chigutisaurid, Compsocerops cosgriffi, *in dorsal, ventral, and lateral views. The highlighted areas estimate the degree of completeness of Simona's skull.*

likely used for electroreception, widespread among temnospondyls. The skull roof is very thin – less than 5 millimetres in places. As more overburden is removed, structural supports may be needed to maintain the fossil's integrity, similar to the associated skull and neck of the ornithopod we call Noddy.

I'm looking forward to resuming preparation of the skull at the museum, once COVID-19 restrictions allow it. Other recently found or prepared temnospondyl fossils include a possible femur sighted by Aidan Lowery at Bore Beach in 2019, a small lower jaw found by Michael Cleeland and under preparation by Paul Chedgey, and a large, nearly complete clavicle prepared by Alan Tait in 2019. The cove in which the skull was found is also notable for the discovery in 1994 of a large megaraptorid manual ungual claw (NMV P186153). However, limited tidal access and the distance from public roads has precluded regular prospecting. Simona's find reinforces the significance of this site, and a return trip via direct entry down the slope would permit a more exhaustive search.

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Image: T Ziegler

Portion of the anterior cranium after initial preparation. The skull roof displays the pitted reticulate ornament, as well as part of the lateral line groove. Two partly eroded teeth are visible at left


Image D Hocking

Temno-spondyl Sleigh Ride

By Tim Ziegler

The discovery by Simona Grippi of Victoria's most complete temnospondyl fossil, in a year of challenges, warrants celebration. Travel limits were already in place by May, but the fossil's significance justified extraordinary approvals. A team was duly assembled to extract Simona's skull. The steep-sided, 60-metre cove was managed by lashing equipment and fossils into a wheelbarrow basin and hauling that up the slope with a rope relay and 4WD winch.

Images: T Ziegler and S Grippi


1. The view into Skull Cove. Any of those boulders could be another winner.


2. Mike talking dino with Chris, from whose property we descended into the site.


3. Belaying down the slope with a high-tech aftermarket V8 wheelbarrow.


4. Mike and Simona celebrate with the skull all over again.


5. The all-important "point to the fossil!"


6. Trimming sandstone overburden to free the boulder.


7. A combination of delicate strategy…


8. … and dirty great hammers.


9. Mike demonstrates proper carrying technique for heavy loads.


10. Cross-section through the left quadrate.


11. Exhausted and elated, back at the top of the cliff: Mike Cleeland, Simona Grippi, Sam Ziegler, Tim Ziegler.


12. Big thanks to the car winch, our honorary MVP.

Image courtesy of P Vickers-Rich

Going Digital with DinoQuest

By Pat Vickers-Rich

An exhibition using our polar dinosaurs to help kids think like scientists launched at the Singapore Science Centre (SSC) in June 2019.

For decades Tom and I have worked with many of the very same staff that are still there at the SSC, taking some of our Australian Expos (such as Dinosaurs of Darkness and Wildlife of Gondwana) to put on show there. These Expos have generated significant income, most of which has been poured into our dinosaur excavations here and elsewhere (such as in Argentina and Saudi Arabia). Some of our team, such as Corrie Williams, Lesley Kool, Wayne Chatwin, Jeff Smith and Mary Walters have been a part of those offshore activities. In addition, funds from these Expos have many times been the source of salaries of some of our long term and still dedicated staff, such as the fantastic preparator Lesley Kool, our caster and preserver Peter Swinkels, and our super-duper artist Peter Trusler — much of his artwork graced this Expo.

Most of these Expos in the past have spotlighted our fossils and explained how they were found and why they were significant. DinoQuest took on a new approach — it was interactive and truly engaged visitors in becoming explorers and scientists, thus encouraging them to think and not just read what someone else has put out there. In addition, one whole wall of this striking exhibition was dedicated to recounting the history of our south polar dinosaur research and field work from its beginnings in the 1970s up to now.

Image: P Vickers Rich

Ferguson's hut

Images: P Vickers Rich

Banners from the exhibition

The beginning of the Expo concentrated on William Hamilton Ferguson, who made that first discovery which led John Long, Tim Flannery, Rob Glenie and later our Dino Dreaming Team to southern Victoria. Ferguson, of course, found the first ever dinosaur bone in Australia, that little claw of some sort of carnivorous dino, near Eagles Nest in 1903. That is where our project and this Expo begins, in Ferguson's field hut.

Because of the long-term friendship of the Monash team with the SSC staff, in a conversation with each other not so long ago, the idea was born to put together a new and up-to-date show incorporating new technologies and animatronics. Technology has moved on since we began our Expo adventures in the late 1900s, and since our Monash Science Centre (now PrimeSCI! group) has had this long-term engagement with the SSC, DinoQuest was meant to be a new adventure, engaging not only the teams at Monash and the Science Centre but in addition two of the Science Centre's partners, DigiMagic and DezignFormat, both based in Singapore. These two groups provided expertise in digital presentation, animatronics and really emphasized interaction between the Expo and visitors from the very start. The SSC, with these two partners, were willing to put the funding forward to make this possible. All we from Monash had to do was provide the specimens and the expertise. Thankfully, expertise and scientific validity was of high priority to all concerned, which in today's world is not always the case. And even more, they were enthusiastic to incorporate many of the docos that Steve Pritchard had put together for us over the years.

More than 200,000 visitors attended DinoQuest over the four month period it was on show from 1 June through to the end of September 2019 (originally to end in August but extended). The crowds were continuous, and the options for school groups and

Image: P Vickers-Rich

Feathered Timimus *animatronic reconstruction based on a new reconstruction crafted by Peter Trusler for launch at the Singapore DinoQuest Expo.*

special events use were in constant demand. PrimeSCI!, working with the SSC, was able to provide a variety of educational options, including *The Box of Dinosaurs* developed long ago by Monash Science Centre crafters, Sanja van Huet, Cindy Hand and myself. The Minister of Education for Singapore launched the Expo, and Atlas Copco (a group which has been deeply involved in all of our work along the south coast of Victoria for decades – thus *Atlascopcosaurus*!), the Australian Embassy and the SSC made sure that the media coverage was significant.

The lead characters in this Expo were designated Prof V and Rex. Tom and I had nothing to do with this selection but, oh well, why not let the DigiMagic Design Team craft the text as they wish! What was quite amazing is that the talking heads of these two explainers would, as three dimensional digital images, show up as visitors walked into different areas and explain briefly what they were about to experience.

Image P Vickers Rich

Rex and Prof V

Here is what the designers came up with:

Prof V: Known as one of the most curious scientists in the world, Prof V is a passionate fossil researcher, who is on a quest to understand the world in which the dinosaurs lived and use this to plan the future carefully and be sure it is sustainable.

Rex (short for T-Rex): A dedicated assistant to Prof V, Rex is an avid fan of dinosaurs who is on a quest to gather evidence to back up his mentor's research and find some ancient mammals.

Hmmm. Not sure about "one of the most curious" or "avid fan of dinosaurs" in these explanations, but we had nothing to do with this description! Tom and I can only wish, eh!

A brief walk through the Expo will give an idea of the breadth, depth and reality of this quite extraordinary and unique presentation — like no other one we have ever been involved with. Although it is now in storage in Singapore and Malaysia, once COVID-19 is under control, it is ready to travel, and we are ready to see that. We hope that it will provide a steady income to keep Dino Dreaming alive and well, as the world has become such a different place.

Visitors entered the Expo through Ferguson's Hut and there collected their data sticks on a lanyard, which contained data on an unknown bone. As they moved through the Expo, they collected more and more data about this unknown bone at different info stations. By the end of the Expo there was enough info on that data stick so that when it was presented to a final station, visitors discovered what kind of beastie was the owner of their unknown bone.

Back to Ferguson's Hut – while visitors were getting the data stick, Prof V and Rex explained to the new visitor who Ferguson was, and his image was up on the screen. Replicas of many of his tools lay around as well as rocks and fossil casts.

Image: P Vickers-Rich

Dig site and explanation of how such digging is done.

Then *Australovenator* attacked, and the visitors ran out of the hut and through a Time Tunnel that took them back to the Early Cretaceous, where Prof V greeted them and introduced them to many of the characters in this ancient time — *Leaellynasaura*, a pterosaur, *Timimus*, *Koolasuchus* and *Minmi* — all animatronics that are making a lot of noise. Thus a good reason to move on.

There were many stations through the Expo beyond Ferguson's Hut. The next station was a digital reconstruction of *Leaellynasaura* where the skeleton gradually had muscles and then skin added to it — all done digitally in a darkened cabinet. Next stop was a stratigraphic column — a series of display cabinets depicting the Precambrian, Palaeozoic, Mesozoic and Cenozoic with a series of beautiful casts and some original fossil specimens. The next station was a large theropod skeleton in a quarry that visitors could walk right up to and see what an excavation might look like. Next to that was Tim Ziegler on the TV screen (in one of Steve Pritchard's docos) explaining how excavations took place, with the cases right in front of him, so that visitors could see what he was using in the video.

From there visitors were able to again visit individual stations to gather more information on their data sticks to help them identify their unknown bones Before that was complete, they had a chance to examine real Dino Dreaming rocks (collected by Mike Cleeland and shipped to Singapore) at a Prep Lab set up in the Expo and carefully peopled by staff who helped the visitors use a scribe to take away layers of sediment in search of new fossils — and some fossil fragments were found and collected.

Other stations beyond this included a reconstruction of the Dinosaur Cove underground excavation where visitors had a chance to use a jackhammer (provided by Atlas Copco, of course), a wheel barrow and even a demolition plunger (which fortunately does not go off!).

Image: P Vickers Rich

Prep lab under construction before the Expo opened.

A most spectacular station came next — a reconstruction of Peter Trusler's art lab with an excellent collection of his Dino Dreaming art, an art table and an electronic panel where visitors could make their own art or digitally colour some of Peter's original images. Beyond that was a skeleton of *Megalania* enclosed in a large glass case, with the digital adding, over a short time, of muscles and skin as Peter's voice talked visitors through how this art reconstruction was done.

Around the corner from the *Megalania* was a parade of polar dinosaurs, or their relatives, including skeletons of *Cryolophosaurus*, *Protoceratops*, a small theropod and an ankylosaur. Just beyond that was a history wall of our polar dinosaur project from Dino Cove to Dino Dreaming and right up to present.

Finally, visitors had collected enough information to get close to identifying their unidentified fossils. After passing by the *Megalania*, the newly crafted life-sized original reconstruction of *Timimus* and the history wall, they walked into Leaellyn Rich's bedroom. There they found a history book that they could thumb through about how her dinosaur, *Leaellynasaura*, was found and why it was named after her, described by a digital image of Leaellyn.

At the end was a station where the data sticks, with all of their information, could be tallied, and the identification of the unknown fossils revealed.

Image: P Vickers-Rich

Leaellyn and Tim Rich making an attempt to explode.

Image: Singapore Science Centre

The giant lizard Megalania

That done, the data sticks were plugged into a printer connection, and printouts of their dinosaurs were presented to the visitor scientists! That was then coloured in by the visitors, rescanned and finally the scans displayed on a large screen. The fossils came to life and moved about. In this area too there were a number of other activities in place for making 3D models of dinosaurs, and the option of talking to the exhibition staff about their findings.

Time to depart, and visitors were provided with certificates of accomplishment along with coloured printouts of their discoveries. And hopefully, there was a feeling of accomplishment as visitors left. They had used the scientific method, learnt something about how scientists and artists work together to come up with reconstructions and had an underlying question to think about: why did these agile and successful dinosaurs become extinct — all but the birds? This question was discussed at several points in this Expo.

Hopefully the DinoQuest Expo will be on the road next year. At present some on-line activities related to it are being developed, so hopefully during this COVID-19 downtime there will be some presence soon of DinoQuest in the ether. Keep a watch on the SSC website: https://www.science.edu.sg.

Image P Vickers-Rich

Peter Trusler's Studio with activities in progress.

Image: Museums Victoria

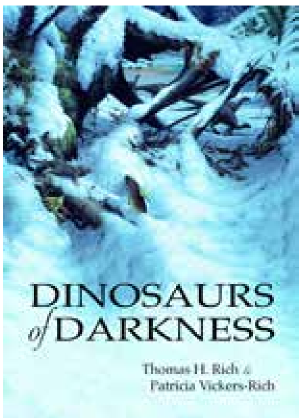
Dinosaurs of Darkness 2nd Edition

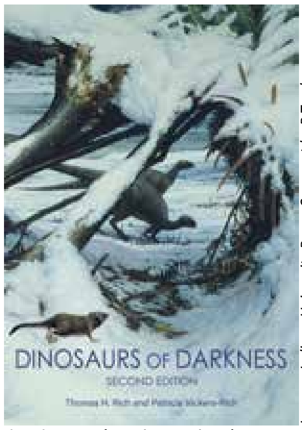
By Tom Rich

Much has happened with the Dinosaur Dreaming project since 2000, the year that Indiana University (IU) Press published the first edition of Dinosaurs of Darkness.

Approached again two decades later about a second edition, IU Press agreed. This new edition both includes what was in the first and recounts what subsequently occurred. Included within it are sections by Lesley Kool, Joy Evans and Leaellyn Rich. Almost all the black-and-white illustrations in the first edition are replaced by colour counterparts in the second.

A rather novel innovation was the addition on the cover of an image of the little mammal *Bishops*. The cover is from an original painting by Peter Trusler subsequently presented to the National Geographic Society in appreciation for their long term support of the Ghastly Blank project — the work being carried out to find and collect the Cretaceous tetrapods along the Victorian coast. It was a landscape view, dinosaurs being on one side and *Bishops* on the other. Both could not be in a portrait view of that painting that would fit on the cover. So Pat had the bright idea of asking Mark Collier (who also prints this Field Report) to produce stick-on images of *Bishops* to be placed on the covers of those copies of the book that we have received from IU Press. Thus far, IU Press has not expressed an interest in acquiring these stick-ons for the remainder of the press run of this book.





Images: Indiana University Press. Cover art by P Trusler

Draft and final covers of the second edition (with sticker)

Image: W White

Black Head-lines

By Alan Tait

The Black Head fossil locality west of Shelly Beach near Kilcunda was discovered in 1989. For a while it was arguably the second richest site, after Flat Rocks, along the Bass Coast, but it has now been somewhat eclipsed by several newer sites.

The headland is formed by cliffs cut into a fluvial channel sandbody. The erosive base of the sandbody, cutting down into overbank sediments, can be seen along the western side of the Black Head rock platform and it continues in the cliff to the west (Figure 1). Measurements of the dip of the bedding and the width of the outcrop indicate that the sandbody is around 30 metres thick — that is, the river that deposited it was at least 30 metres deep allowing for compaction of the sandbody during burial. A meandering river this deep is likely to have been around one kilometre wide.

The fossil-bearing layers occur on the shore platform at the base of a cliff projection or spur at the west side of the headland (Figure 1). The fossiliferous area is separated from most of the exposed sandbody by a northeast-trending fault across which the sandbody drops down to the southeast by several metres taking the extension of the fossil-bearing layers below the shore platform surface.

In the fossiliferous area, there are three fossil-bearing layers separated by sandstone layers with concretions (Figure 2). The fossiliferous layers consist of sandstone with plant fragments and mudstone clasts as well as fossils. The basal fossiliferous layer is flat but the middle and upper layers dip towards the cliff. The layers are part of a sandbar about 4 metres high and at least 20 metres wide (cut off by the fault) which moved northeastwards, depositing alternate layers of fossil-bearing and non-fossil-bearing sand (Figure 2). At the high rate of flow at the base of a large deep river, alternating layers of material may be due to natural pulses in the turbulent water flow, sorting of the material during transport or different sources of material being eroded upstream of the depositional site.

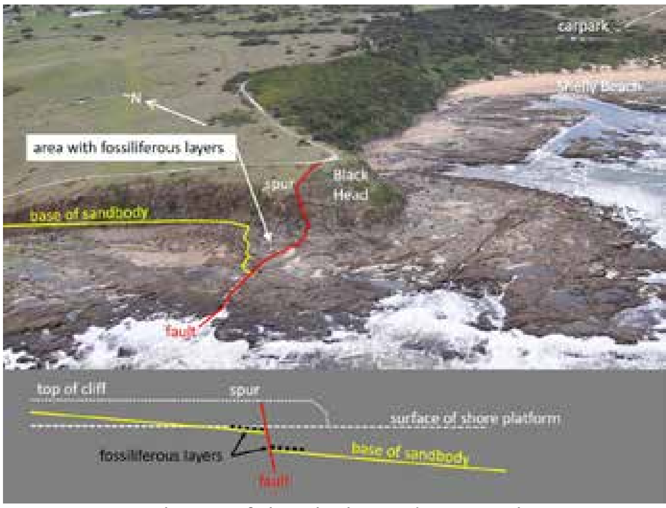


Image: Monash University / A Tait

Figure 1. Aerial view of the Black Head area with diagrammatic cross-section showing fossiliferous layers cut by fault.

The final item transported across the top of the sandbar by the river was a tree at least 5 metres long (and maybe twice that length) which got stuck across the crest. The tree is aligned parallel to the current but turbulence around its downstream section eroded part of the front of the sandbar before a layer of massive sand swept over the top, burying the tree and the sandbar (Figure 2).

Although the southeast part of the fossiliferous area has been downfaulted below the surface of the shore platform, there is another item of sedimentological interest on the downfaulted side. The exposed sandstone layer contains plant fragments but also various sizes of mudstone clasts. One mudstone

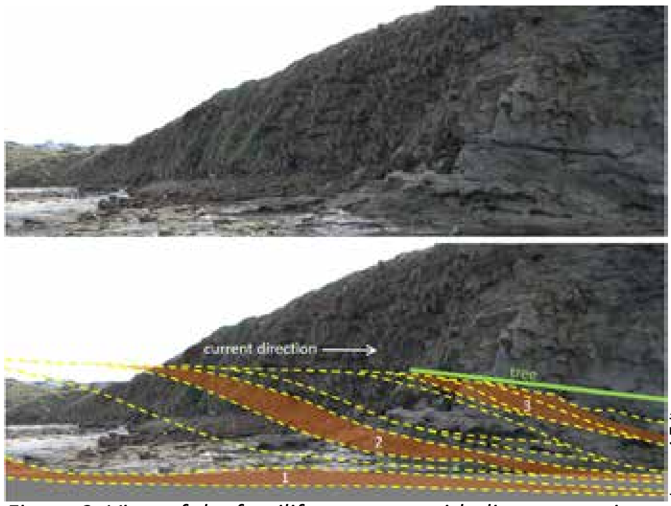


Image: A Tait

Figure 2. View of the fossiliferous area with diagrammatic reconstruction of bedform showing three fossiliferous layers (shaded) and tree transported across top of sandbar.

Image: A Tait

Figure 3. Overturned mudclast in unfossiliferous area southeast of fault. Inset shows details of soils, coal and burrow. Turn page upside down to view original orientation of soils in inset. White metre rule is folded in half.

clast near the base of the cliff is around 0.5 metres thick and 6 metres wide or long (Figure 3). It consists of parts of two soil layers, one with a large vertical burrow, separated by a thin coal. Soils within the Strzelecki Group typically consist of pale grey mudstone grading up into purplish-brown mudstone overlain by a thin coal. Applying this pattern to the soils in the mudstone clast indicates that the clast is upside down and must have been flipped over at some stage during erosion and transport at the bottom of the river, demonstrating the huge power of the river that deposited the Black Head sandbody.

The local current direction in the Black Head channel sandbody is towards the northeast which is upvalley in the overall regional river direction. However, this is not a problem because of the meandering channel origin of the sandbodies in the Strzelecki Group. Measurements of flow direction taken along the length of meandering rivers show a wide range of directions, in many cases to all points of the compass, while similar measurements in braided rivers show a narrower spread of flow directions. Thus, having portions of the channel flowing upvalley can be taken as evidence for the meandering river model.

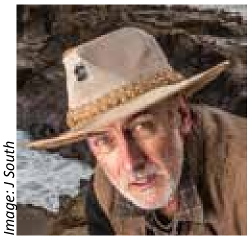


Image: J South

Koonwarra Roadworks

By Mike Cleeland

Work has begun on realignment of a stretch of the South Gippsland Highway between Koonwarra and Meeniyan, locally known as the Black Spur.

The roadworks pass close to the well known Koonwarra Fish Beds, so it's quite possible that the excavation will intersect the fossil layer at some point.

I've been appointed by CPB Contractors to be geologist/ palaeontologist for the project, the object being that if the fossil layer is intersected the rock will be saved instead of used as fill.

Arrangements have been made to store any fossiliferous rock at the Koonwarra Village School nearby, after which it will be available for dig crews to work on.

The way the road bends on this part of the highway has resulted in frequent run-off-road crashes, freight delays and safety concerns.

To fix this, the Australian and Victorian Government has invested $115.2 million to realign the highway and make it easier and safer to travel through the area.

For more information, see https://roadprojects.vic.gov.au/projects/south-gippsland-highway

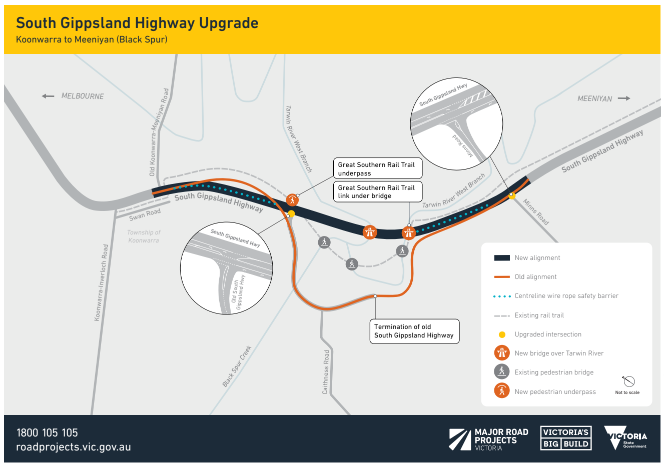


Image: Major Road Projects Victoria

Map of proposed highway realignment

Image: Gavan Mitchell

Evolving Images of Iguanodon

Image: Museums Victoria

By Rohan Long and Tom Rich

It's easy to forget that the illustrations and models of dinosaurs we see in books and museums are artistic constructs. They are informed by science — the good ones, anyway — but scientific knowledge is constantly changing and updating, and a reconstruction that is thought to be accurate today may be superseded by the next big discovery. The earliest reconstructions of prehistoric life were produced in the 19th century, at a time when an understanding of what dinosaurs actually were was slowly being elucidated. One of the first dinosaurs discovered, and one that was the focus of some of the earliest reconstructions, was *Iguanodon*.

In the summer of 1822, Gideon Mantell, a country doctor, while doing his rounds accompanied by his wife Mary, looked for fossils near Sussex, England. He and Mary found a number of isolated teeth amongst the gravel in the recently paved road over which they travelled. Gideon knew that the fossils came from "Secondary Rocks" — what we now call Cretaceous. Given the size and form of the teeth, Gideon identified them as those of an herbivorous reptile. Gideon recognised the similarity of the form of his fossils to the much smaller teeth of iguanas that had been shown to him at the Hunterian Museum. Hence, he would eventually christen his fossil *Iguanodon* ('iguana tooth'), in a paper accompanied by illustrations made by his wife Mary (Figure 1).

In 1834 a partial skeleton of *Iguanodon* was found by an alert quarry owner in Maidstone, England. Learning of the discovery, Mantell hurried to the site and purchased the fossil for £25. A partial tooth and the mould of a second tooth showed that this was also *Iguanodon*. Attempting to visualise what the complete skeleton of the Maidstone *Iguanodon* might have looked like, Mantell drew Figure 2. In 1842, England's foremost anatomist, Sir Richard Owen, proposed the concept of Dinosauria. This was based on *Iguanodon* and two other species, all defined by fragmentary material found in the United Kingdom. Owen characterised dinosaurs as huge reptiles with an upright posture similar to birds and mammals, rather than the sprawling posture of living reptiles.

In the early 1850s, fifteen life-sized models of dinosaurs and other prehistoric animals were constructed and placed in Crystal Palace Park, London. The park was created as a new home for the Crystal Palace, an enormous cast-iron and glass building constructed as the display space for the 1851 Great Exhibition held in Hyde Park. Although the Crystal Palace itself was destroyed by fire in 1936, the dinosaur sculptures are still present in the park today (Figure 3.).

The sculptures were designed by Benjamin Waterhouse Hawkins, a sculptor and illustrator who had studied natural history and geology. He worked under the direction of Owen to create scientifically accurate, lifelike models that were then displayed in a naturalistic, outdoor setting. Additionally, small-scale models of the dinosaurs were made for the purpose of scientific studies in schools and other educational institutions (Figure 4). Examples of these miniature models are held locally by Museums Victoria and the Tiegs Zoology Museum at the University of Melbourne.

Image: G Mantell

Figure 1. Gideon Mantell's Iguanodon *teeth, 1825*

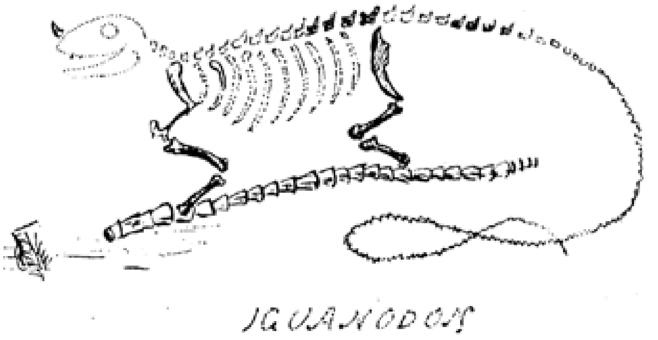


Image: G Mantell

Figure 2. Mantell's 1834 sketch of the Maidstone Iguanodon

The *Iguanodon* that is portrayed in these models, and illustrations from the time, is a heavy quadrupedal, elephantine beast with a horn on its nose. The most striking inaccuracy of this reconstruction is this horn, first proposed by Mantell. The 'horn' was quickly realised to be a thumb spike and removed from all subsequent *Iguanodon* images. The massive, lizard-like animal that Owen envisioned looks unlike any dinosaur we know of today, but then it was based on a handful of incomplete skeletons. It's worth acknowledging too, that the idea of a giant, herbivorous reptile was a totally unprecedented concept at the time, with no real analogue among modern animals. Owen's placement of the limbs under the body rather than assuming a sprawling posture was in concordance with his insight that the Dinosauria were unlike lizards, crocodilians and turtles.

The next dramatic change in the conception of *Iguanodon* occurred in 1878, when an incredible discovery was made in Bernissart, Belgium. While excavating underground, workers at a coal mine stumbled upon a huge accumulation of dozens of *Iguanodon* skeletons, many of them complete. Work on the Bernissart specimens was carried out under the supervision of palaeontologist Louis Dollo. Prior to excavation of the fossils, sketch maps were made of the skeletons to facilitate reconstruction and analysis after the bones had been prepared above ground. Based on the broad similarity of these skeletons' proportions to those of kangaroos, Dollo used them as the basis for mounting the dinosaurs.

Image: R Long

Figure 3. Iguanodon *models at the Crystal Palace Park, London in 2019.*

Reconstructions from this era reoriented *Iguanodon* into a stiff, upright 'tripod' stance commonly used by kangaroos and other macropods today. As if to highlight the correction of past errors, the thumb spikes are held out prominently, giving the impression that the saurian is offering the viewer an enthusiastic thumbs up. This depiction of *Iguanodon* persisted for around a century, and it was the image first encountered by many of us in the children's dinosaur books of the early eighties (Figure 5). However, as is often the case, the portrayal of dinosaurs in popular culture was lagging behind the science.

In 1980, British palaeontologist David Norman published a paper challenging the previous reconstruction. A key piece of evidence was the recognition of ossified tendons extending from the lower part of the back onto the anterior part of the tail. This region of the vertebral column is unable to bend, and the upright kangaroo posture was not physically possible. Reviewing the Bernissart *Iguanodon* specimens after almost a century, Norman recognised that in order to mount the specimens in an upright posture, Dollo had to break the tail in a number of places. Norman then went on to show that *Iguanodon* had a lattice work of ossified tendons on the vertebrae in the lower back and the base of the tail. Finally, he found that all articulated *Iguanodon* specimens had tails that were either nearly straight or curved downward — an arrangement incompatible with the upright posture.

Image: Lee McRae

Figure 4. The miniature Iguanodon *model based on the Crystal Palace sculptures. This specimen is from the collections of University of Melbourne.*

Norman recognised two species of *Iguanodon*, *I. bernissartensis* and a more gracile *I. mantelli*. With proportionally more elongate forelimbs, *I. bernissartensis* may have been more consistently quadrupedal in its movements. In 2007, because of the differences between the two species, *I. mantelli* was placed in a new genus *Mantellisaurus*.

The *Iguanodon* that has been reconstructed from these modern developments is a slimmed down quadruped with a horizontal posture, its tail raised in the air. Although predominantly walking on four legs, it is thought that *Iguanodon* would regularly switch to a bipedal stance if needed. The model pictured, produced by Museums Victoria preparator Susan Scott, is typical of contemporary reconstructions (Figure 6).

And so, modern study has brought us full circle, and *Iguanodon* is once again considered (mostly) quadrupedal. Despite often being held up as a classic example of science getting it wrong, it turns out that the Victorian scientists' initial reconstruction got a surprising number of things right – particularly given the paucity of material they had to work with. Based on the available fossils, the hypotheses they came up with were quite plausible. Any student of the history of palaeontology should be wary of the notion that current reconstructions aren't every bit as much a work in progress as their predecessors. Imagine how silly all of these featherless dinosaurs are going to look to the next generation of dinosaur devotees.

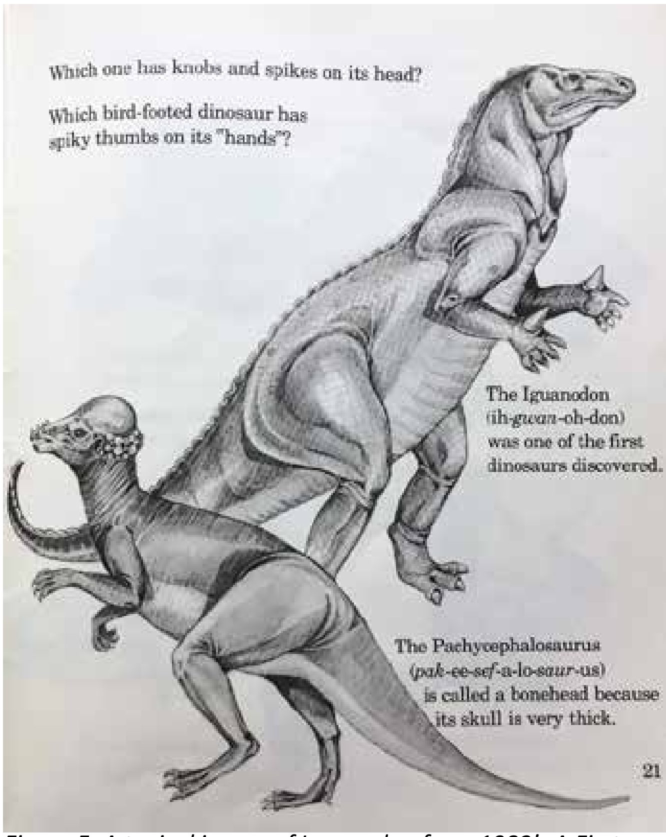


Image: R Long

Figure 5. A typical image of Iguanodon from 1982's A First Look At Dinosaurs

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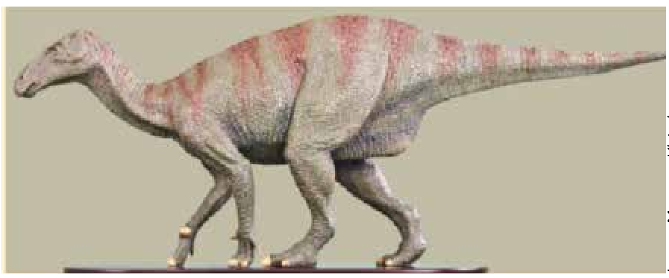


Image: Museums Victoria

Figure 6. Museum Victoria's 1990 model Iguanodon

Image: Museums Victoria

Mary is an Ace!

By Tom Rich

As she was breaking rock in Lesley's driveway last December, Mary Walters finally did what I long knew she would. Because of her persistence, she found her fifth Cretaceous mammal specimen. Finding it made her an "ace", the first person on the crew to have found that many fossil mammals. Becoming an ace was the distinction given to fighter pilots in the World Wars who had five victories over their opponents. None of them took fifteen years to reach that number as Mary did because (fortunately) the wars did not last that long. Mary's first "victory" occurred in 2004 when she discovered the holotype of *Corriebaatar marywaltersae*, the first multituberculate mammal to be found on the Australian continent — not a bad start.

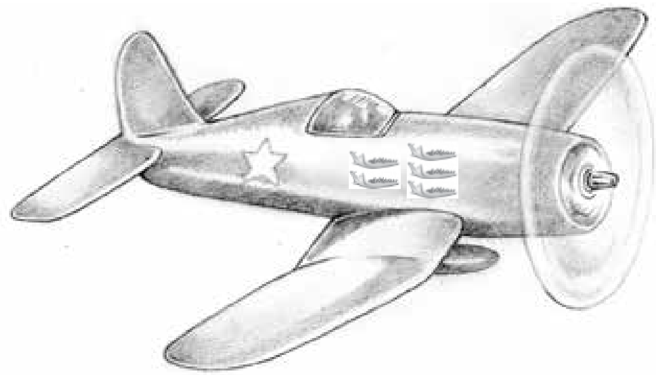


Image: S Madder (using mammal jaws by P Trusler)

It was customary for an emblem to be put on their aircraft of a fighter pilot to mark each victory. By analogy, an emblem of a Cretaceous mammal is depicted on this image of Mary's imaginary aircraft.

Image: W White

Mary with her mammal jaw moments after it was recognised

Image: L Nink

Win Chedgey

By Wendy White

In December 2019, after a long bout of illness, Dinosaur Dreaming lost one of our most colourful diggers.

At the 2004 Field Season, Winifred (Win) Chedgey arrived at Flat Rocks, dragged along, I expect, by her dinosaur-mad Museums Victoria volunteer husband Paul. She stayed for six field seasons.

Over this time, Win astonished and entertained the crew with her love of bright clothes — the more outrageous the better. She refused to dress like an old lady, and sported gaudy, flamboyant, pretty outfits bringing joy into her life and that of those around her.

Win was not a posh or pretentious person — she resonated with a homely down-to-earth love of family and a generosity of spirit that touched many of the dig crew. She was devoted to her husband Paul, her children and grandchildren, and entertained the crew with stories of their exploits. She was fond of all living things, becoming very friendly with George, the Cape Paterson neighbourhood cat.

Win was quick to laugh and showed a natural and easy compassion. Despite growing mobility issues (she would cheerfully explain the spur on her knee to anyone who asked), Win could be seen good-naturedly chasing crew members (usually the late David Pickering) around the table — the comedic result of yet another bout of good-natured teasing.

Dinosaur Dreaming is less sparkly with her passing.

Image: W White

Win Chedgey breaking rock at Cape Paterson in 2011


Image courtesy of P Swinkels

Moulding Footprints

By John Swinkels and Peter Swinkels

An eagle-eyed snoop, regularly lurking around the Inverloch foreshore, has recently spotted a multitude of fossils, but also some subtle traces that to most people would have been overlooked. Melissa Lowery has discovered a series of small dinosaur prints, possibly ornithopods; a large theropod print with a 496 millimetre mid toe length, and some arthropod tracks.

We recently made two moulds at Inverloch, one containing several of these small prints and one containing the large single theropod print.

Another mould was made of a slab containing some arthropod tracks.

The large theropod print is in sandstone approximately 80 millimetres thick with multiple fractures through it. Below it is a thick mudstone layer, so removing it would most likely cause it to break up. Moulding fossil tracks or traces on site enables accurate copies to be produced while leaving the originals there.

The footprint location on the shore platform is covered by the tide every day so the mould needed to be produced between these tides.

The area is first swept clean of loose debris and a small clay wall placed around the area to be moulded to contain the silicone. The moulding medium chosen was


Image: L Kool

John and Peter Swinkels apply Pinkysil® inside the clay wall


Image: L Kool

Peter Swinkels makes the plaster jacket

Pinkysil®, a fast set RTV silicone rubber. It is perfect for this sort of work, as it flows freely and sets in around 15–20 minutes. Before the silicone is removed, a fibreglass or plaster jacket is made to support the flexible silicone so once it is removed it maintains the accurate shape of the print and surrounding rock.

Many products could be used to make copies, but for the larger ones fibreglass is a good product that is relatively light and strong. Pigment is usually added to the Polyester resin to provide a good base colour for painting. Once the cast has been trimmed and cleaned of any imperfections and air bubbles, it is painted to try and match the original fossil.

After the small ornithopod prints were cast, we noticed what appears to be scale impressions in the base of some of the toes. Sometimes details that are not noticeable on site in the bright light and dull non-reflective surfaces of sandstone become visible in a cast. Even going back to look at the originals you can't see the scale impressions that are visible in the cast.


Image: L Kool

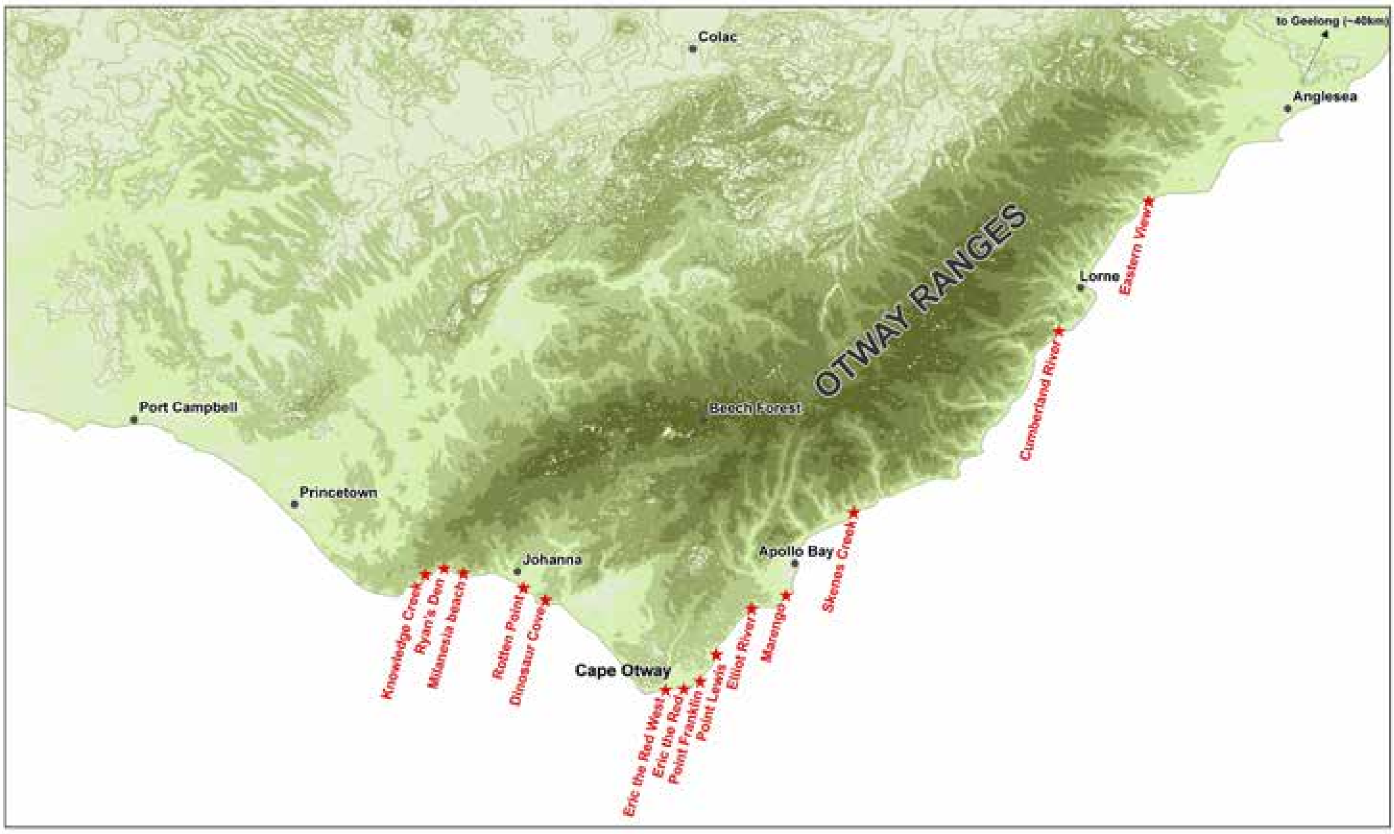
Peter and John Swinkels remove the Pinkysil® mould

Oi! Where are you?

Image: W White

By Sharyn Madder

Cretaceous Vertebrate Localities in the Otways



TAXA	Knowledge Creek	Ryan's Den	Milanesia Beach	Rotten Point	Dinosaur Cove	Eric the Red West	Eric the Red	Point Franklin	Point Lewis	Elliott River	Marengo	Skenes Creek	Cumberland River	Eastern View
Mammalia:														
Australosphenidae (Unidentified)						X								
Bishops sp.						X								
Monotremata (Unidentified)						X								
Kryoryctes cadburyi					X									
Dinosauria:														
Dinosauria (Unidentified)		X		X	X	X	X	X	X	X	X			X
Ornithopoda (Unidentified)		X		X	X	X		X	X	X	X			
Atlascopcosaurus loadsi					X				X					
Diluvicursor pickeringi						X								
Fulgurotherium australe					X									
Leaellynasaura amicagraphica					X									
Ankylosauria (Unidentified)					X									
Neoceratopsia (Unidentified)					X									
Theropoda (Unidentified)					X	X		X						
Tyrannosauroidea					X									
Timimus hermani					X									
Megaraptora					X	X								
Ceratosauria:Elaphrosaurinae						X								
Other Vertebrates:														
Plesiosauria (aquatic reptiles)					X	X							X	
Crocodyliformes (crocodiles)					X									
Pterosauria (flying reptiles)					X	X								
Testudines (turtles)		X			X	X	X	X	X					
Otwayemys cunicularius					X									
Dipnoi (lungfish)					X	X			X					
Neoceratodus nargun					X				X					
Actinopterygii (ray finned fish)					X	X								
Trace Fossils:														
Dinosaur footprints	X		X		X							X		
Bird footprints					X							X		
Dinosaur burrows	X													


Image: W White

Recently Prepared Fossils

Photos by Lesley Kool

Theropod tooth in erratic from The Arch

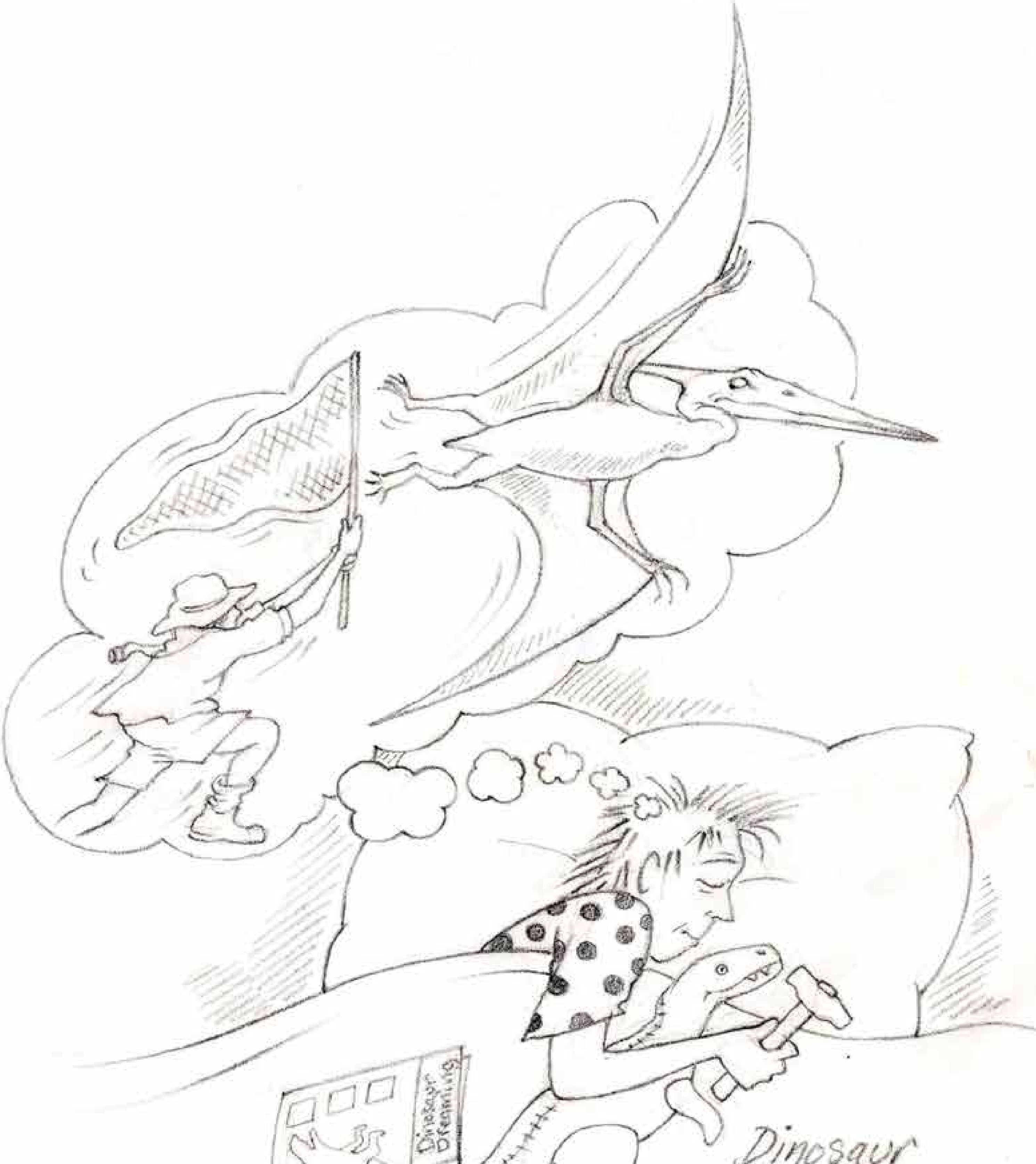

Ornithopod femur from south of Mary Anning site

Partial theropod vertebra from near the Honey Locality


Weird flat bone from San Remo


Tiny lungfish tooth plate


Temnospondyl centrum


Dinosaur Dreaming
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