

PROGRAM & ABSTRACTS

19th Conference on Australasian Vertebrate Evolution, Palaeontology and Systematics



CAVEPS 2025

ADELAIDE
KAURNA YARTA

CAVEPS 2025 Adelaide

Flinders University, Adelaide, South Australia

Monday 24th – Friday 28th November 2025

CAVEPS 2025

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KAURNA YARTA



Hosted by:



Flinders
University



CAVEPS 2025 has been supported by:



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Acknowledgement of Country:

CAVEPS acknowledges the Kaurna people as the Traditional Owners and continuing Custodians of the Country on which this conference is held, the sovereignty of which has never been ceded. We recognise the enduring connection to Country that all First Nations peoples have and its deep cultural significance. deep time encoded into its landscapes and fossils.

We pay our respects to Elders past and present and extend that respect to all First Nations peoples on whose lands we work. We also acknowledge some of the world's oldest cultures, passed down from a time when humans walked amongst a menagerie of now-extinct megafauna.

CAVEPS Logo

Jonathan Cramb designed our fantastic logo which features some iconic South Australian fossil taxa including the plesiosaur *Umoonasaurus desmoscyllus*, the lungfish *Metaceratodus wollastoni*, the echidna *Megalibgwilia owenii*, and the flamingo *Phoeniconotius eyrensis*. The logo is available on t-shirts and other merch that you can order direct from Toothy Grin <http://caveps2025.toothygrin.com.au>



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Welcome

Marni naa pudina (Good you all came).

Welcome to the 19th Conference on Australasian Vertebrate Evolution, Palaeontology and Systematics, hosted by **Flinders Palaeontology** and held on Kaurna Yarta (Kaurna Country) at the Tonsley Campus, Flinders University, Adelaide. We are pleased to present a multidisciplinary forum showcasing the latest research on vertebrate morphology, phylogeny, systematics, evolution, development, zooarchaeology and palaeoecology, bringing together vertebrate palaeontologists, earth scientists, evolutionary biologists, and fossil enthusiasts from Australasia and around the world.

CAVEPS 2025 commences on Monday 24 November with seven workshops spanning diverse topics in vertebrate palaeontology, from publishing and being media-savvy, to understanding your research impact, learning about the latest insights into 3D-modelling, some lessons in moulding and casting, to managing collaborations with First Nations peoples. Our Welcome to Country with Senior Kaurna Man Uncle Mickey Kumatpi O'Brien invites all visitors to connect with the culture and people of Country. Across the four days of scientific sessions, we will be regaled by our four distinguished plenary speakers. In addition, CAVEPS 2025 will feature 76 scientific presentations and 36 posters covering the multitude of facets of vertebrate palaeontology and evolution.

Our social program includes a Welcome Function on Monday and the Conference Dinner at the Marion Hotel on Thursday, and pre- and post-conference field trips to the World Heritage listed Naracoorte Caves in the south-east, and to the arid interior of South Australia to visit Lake Pinpa and Ikara-Flinders Ranges respectively.

We are grateful to the many people who have contributed to the organisation of CAVEPS 2025. We extend our thanks to all of you, from plenary speakers, field trip organisers, symposium organisers, session chairs, judging panels, those who donated auction items, and all the other volunteers. We thank the many sponsoring organisations and individuals who have generously supported the conference.

We wish you a successful and memorable conference in Adelaide.

Committee

The core committee of CAVEPS 2025 are Dr Alice Clement, Dr Diana Fusco and Dr Aaron Camens, supported by the Flinders University Palaeontology Group and many external contributors.

Website: caveps.org

Email address: caveps.palaeo@gmail.com

Facebook group:

<https://www.facebook.com/groups/418078698316877>

Follow the QR code to view the online schedule and program



The **main conference sessions** will be taking place in the 160-seat Theatre 1 at the Flinders University Tonsley Campus (this is 5-mins drive down the hill from the Bedford Park campus). There is space for "spill-over" in Tonsley Theatre 2. Both can be found on the ground floor of Tonsley Building.

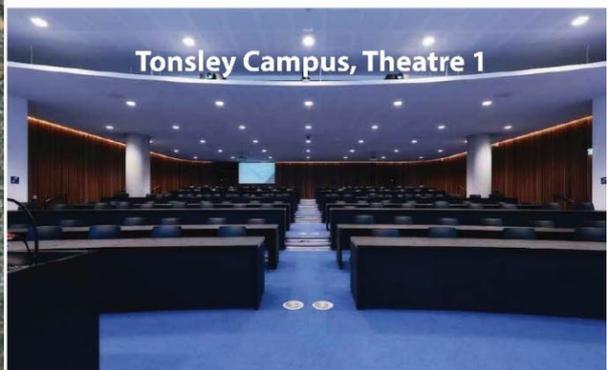
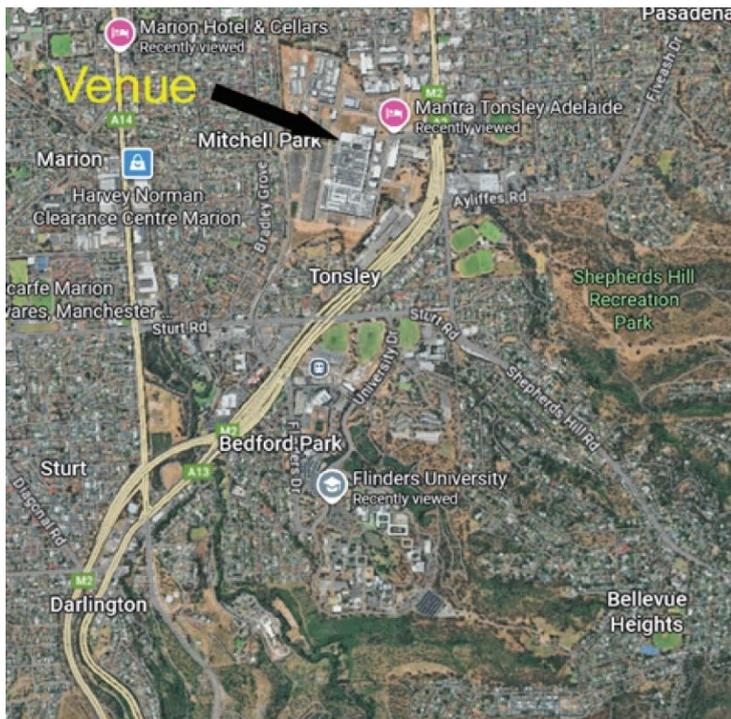
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Location & site information

Workshops on Monday 24 November will be held at Tonsley, excluding the moulding and casting workshop with Carey Burke which will be held on the Bedford Park campus of Flinders University.



Registration

Registration will be available on the ground floor of the Tonsley Flinders Building foyer: 8:00 am-4:00 pm Monday 24th of November

7:30 am-4:30 pm Tuesday 25th of November

7:30-8:00 am Wednesday 26th of November

7:30-8:00 am Thursday 27th of November

7:30-8:00 am Friday 28th of November

Transport Information

For details on getting to the Tonsley Campus, Flinders University, please see the websites and map:

<https://tonsley.com.au/getting-to-and-from-tonsley/>

<https://www.flinders.edu.au/campus/bedford-park/location/public-transport>

Visit the [FLNDRS](#) route information page for train times, or [Adelaide Metro](#) for all timetable information.

To ride the loop buses between Tonsley and Bedford Park campuses, Flinders staff/students can swipe their Flinders card, all others, please tell the driver you are a guest with the CAVEPS conference to access the buses.

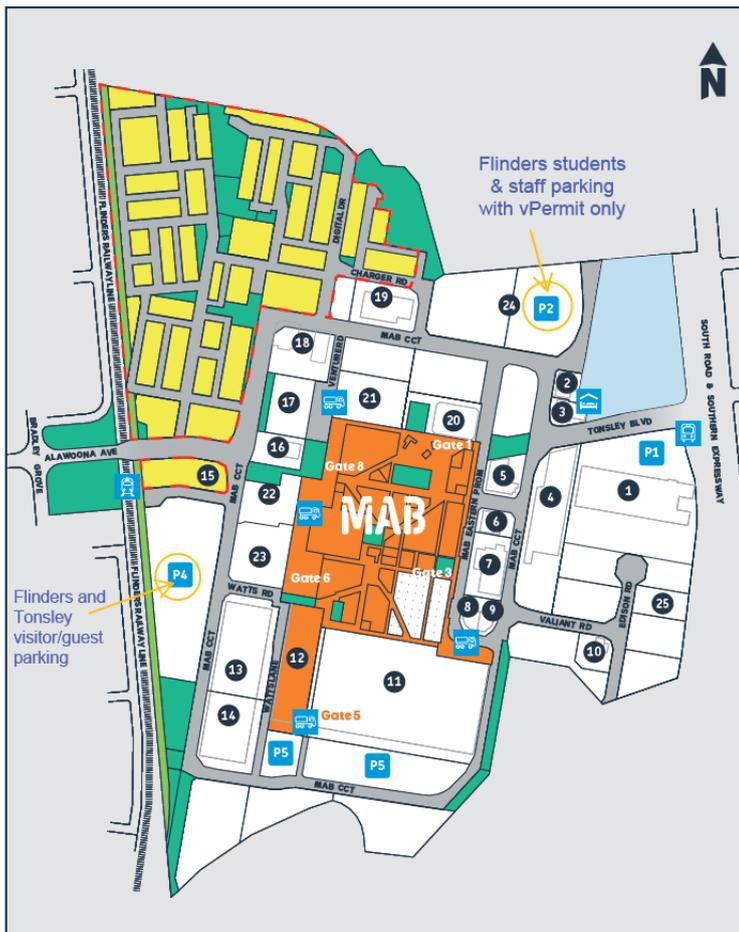
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Parking is available on the Tonsley Campus car park. Visitors should park in the free Tonsley public car park, car park 4 (P4) - located on the southwest side of the Main Assembly Building (MAB), adjacent to the Tonsley train station.

Tonsley Innovation District | Parking



Key

- P** Car parking
- P1 Tonsley Admin Building tenants only
- P2** Flinders University students and staff only
- P4** Flinders and Tonsley visitors car park
- P5 TAFE SA car park only

- Mantra Tonsley Hotel
- Tonsley Railway Station
- Adelaide Metro Bus Stop
- Loading Dock / Deliveries
- Park / Plaza / Reserve
- Greenway Shared Path
- Tonsley Village / Residential

MAB Main Assembly Building

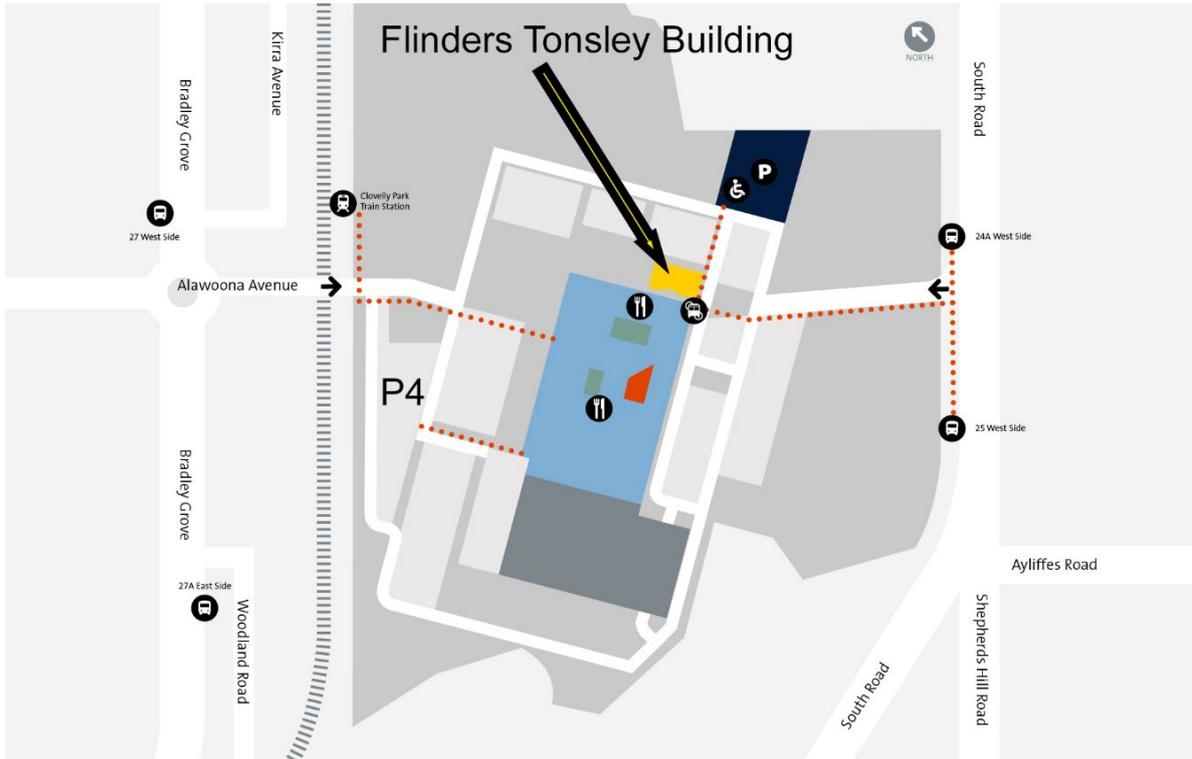
- 1 Administration Building
- 2 Autism SA
- 3 Mantra Tonsley Adelaide
- 4 State Drillcore Library
- 5 Nice Australia
- 6 Radical Torque Solutions
- 7 Siemens Energy
- 8 Accurate Dosing Systems
- 9 Link Assistive
- 10 Hydrogen Park SA
- 11 TAFE SA
- 12 Line 0
- 13 Collectiv Group
- 14 Specialised Solutions
- 15 Tonsley Village Sales & Info Centre
- 16 Brewery
- 17 SA Power Networks Substation
- 18 Chrysos Corporation
- 19 Ziptrak

- 20 Flinders University
 - College of Science & Engineering
 - New Venture Institute
 - Australian Industrial Transformation Institute
 - Medical Device Research Institute
 - Institute for Nanoscale Science and Technology
 - CGTR – Centre of Growth and Transitional Research
 - CDERT – Centre for Defence Education Research and Teaching

- 21 Flinders Factory of the Future & Tonsley Technical College
- 22 Tonsley retail precinct
- 23 Junction development
- 24 Future commercial car park site
- 25 Trojan Camping & 4x4

MAPS OF VENUE

<https://www.flinders.edu.au/content/dam/documents/campus/maps/tonsley-maps.pdf>



TONSLEY BUILDING PLAN (GROUND FLOOR)

- | | | |
|------------------------|------------------------------|------------------------|
| Concierge | Parenting Room | Meeting Rooms |
| Lifts | Disabled Toilet / Shower | Wayfinding Touchscreen |
| Toilets | Prayer Rooms Male and Female | Display Screen |
| Male Toilets/Showers | Secure Bike Storage | Kitchenette |
| Female Toilets/Showers | Tonsley Theatres | Back of House Areas |
| | | Entry/Exit |

CAVEPS 2025 code of conduct

CAVEPS is committed to creating an accessible, inclusive, and safe environment for everybody, regardless of sexuality, gender, identity, age, ability, or culture. Discrimination and harassment of any kind have no place at our conference.

Anyone requested to stop unacceptable behaviour is expected to comply immediately. We reserve the right to remove any individuals that may not be abiding by our code of conduct.

Questions and discussions should be respectful, constructive and focus on ideas rather than individuals.

Much of the work presented at CAVEPS is unpublished, some is under public embargo. Do not take or disseminate photographs, recordings, or reproductions of materials presented as part of CAVEPS without the express permission of the author(s).



No food or drink may be taken into the lecture theatre. Water in a sealable bottle is allowed. Food and drink can be consumed in the restaurant and cafe areas outside or in the designated sitting areas in the foyer.

Support for CAVEPS Delegates while at Flinders University*First Aid*

During the conference, for life-threatening emergencies, always call **000** first, and then Security on **(08) 8201 2880**. For non-emergencies, please call Security.

Other incidents

These incidents should be brought to the attention of Flinders University security (**8201 2880**) or security@flinders.edu.au) in the first instance. If you have any other questions or concerns, please bring these to the attention of the CAVEPS Organising Committee:

- Aaron Camens aaron.camens@flinders.edu.au ph: 08 8201 3302
- Diana Fusco diana.fusco@flinders.edu.au ph: 0408 830 728
- Alice Clement alice.clement@flinders.edu.au ph: 08 8291 6035

Social Program

Welcome Function – Monday 24 November 4:45-7:30 pm

CAVEPS will officially start outside the Flinders Tonsley building with a Smoking Ceremony and Welcome to Country by Senior Kaurna Man Uncle Mickey Kumpati O'Brien at 5pm.

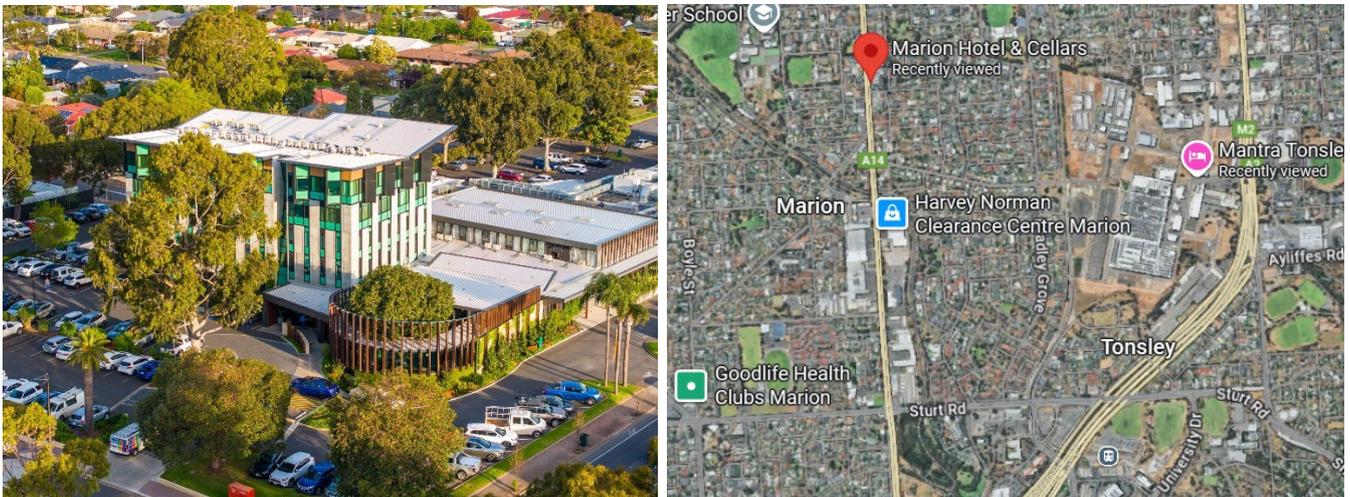
At around 5:30 pm, we will move across the road to the Mantra Tonsley Hotel where registered delegates can enjoy local beverages and native-food themed canapes. Vegan, vegetarian and gluten-free options will be available. <https://www.mhtonsley.com.au>. You must have registered to attend, and additional guests are not allowed.



Conference Dinner & Auction – Thursday 27th November, arrival from 6:00 pm, seated by 6:45 pm.

The conference dinner (tickets sold separately, this must be pre-purchased prior to the conference) and CAVEPS Fundraiser Auction will be held in the Secret Garden and Glasshouse, Marion Hotel, 849 Marion Road, Mitchell Park (Phone 8276 8888) <https://www.marionhotel.com.au> This venue is a ~20 minute walk from the Tonsley campus, but can also be reached by bus from Flinders University.

The aim of the CAVEPS Fundraiser Auction is to help raise funds as an ongoing contribution to the perpetual organisation of CAVEPS. This will aid us in continuing to maintain low registration fees for the conference and allow us to support various initiatives, including student travel grants. Dig deep and be generous to help support the future of vertebrate palaeontology in Australasia! For those not attending the dinner but still wanting to bid, an auction booklet will be made available.



Field trips

Pre-conference field trip: Naracoorte Caves, Friday 21st – Saturday 22nd November

The pre-conference field trip will take delegates to the Naracoorte Caves World Heritage Area, home to Australia's most complete Pleistocene fossil record. The journey to Naracoorte will take us through the historically and geologically significant south-east. At Naracoorte, we will receive guided tours of Victoria Fossil Cave, Alexandra Cave, and Blanche Cave, where we will hear about ongoing work from researchers at the University of Adelaide, as well as the Bat Observation Centre. Those wishing to will also have the option to go adventure caving, and a visit to a local winery.

Learn more: <https://www.naracoortecaves.sa.gov.au/>

Post-conference field trip: Lake Pinpa and Ikara-Flinders Ranges 29th Nov – 4th Dec

The post conference field trip will take delegates to visit a range of sites where fossils have been found from the late Oligocene Namba Formation. After a brief visit to the amazing Arkaroola geological preserve, with rocks up to 1.6 billion years old, we will visit Nilpena Station to see the exquisite Ediacaran fossil beds dating back to the origin of complex life around 550 million years ago (<https://ediacarafoundation.org/lifes-beginning/>). We complete the trip with a visit to the geological trail in Brachina Gorge, see the only Golden Spike in Australia, and return to Adelaide.

Learn more: <https://www.parks.sa.gov.au/parks/ikara-flinders-ranges-national-park>

CAVEPS merch & Market stalls

Dr Jonathan Cramb (Head Grinner and friendly neighbourhood palaeontologist) who designed our fabulous conference logo is providing you the chance to get some seriously good conference swag featuring the plesiosaur *Umoonasaurus desmoscyllus*, the lungfish *Metaceratodus wollastoni*, the echidna *Megalibgwilia owenii*, and the flamingo *Phoeniconotius eyrensis* (and more!) Purchase your own conference t-shirts and other merchandise via: <http://caveps2025.toothygrin.com.au>



We are fortunate to have a bunch of creatives who will be offering their creations in the entrance foyer at CAVEPS. Market stalls rotate, so please check with the stall holder to find out which days they will be attending.

Flinders University Palaeontology Society are a student run society. Their market stall offers a bunch of palaeo themed merchandise including books, wearables, stickers & much more.

Jade De Silva creates nature-inspired lino prints, stickers, patches, and upcycled lino-printed clothing. At CAVEPS, Jade will also offer interactive lino printing, where you can print on your own clothes! Prices will vary depending on the size of the design. Bring your own pre-laundered cotton or denim clothing (no fuzzy or knit fabrics) to have it printed with one of my designs. Find more info, examples, and updates on Instagram or Facebook: [@J4dedesilva](https://www.instagram.com/J4dedesilva)

Toothygrin sells natural history-themed button badges, greeting cards, and assorted organic and inorganic detritus. Online shop: toothygrin.com.au Socials: **@toothygrinart**

Karina is a third-year palaeontology student at Flinders University with a passion for ichnology! She loves to create art, and in her spare time, designs keychains, magnets and stickers of her favourite Australian megafauna. Karina will be selling her art at CAVEPS on Tuesday and Wednesday (25th and 26th).

Sebastián has just finished his second year in the paleontology degree at Flinders University. He is representing the Chilean Paleoart Society and has partnered with multiple paleoartists to celebrate Australian Palaeontology. His stall will have a nice selection of stickers, prints, keychains and puppets of the Australian palaeo biota.

Tourism

For general tourist information on Adelaide and South Australia, please visit <https://southaustralia.com/products/adelaide/information-services/adelaide-visitor-information-centre> and <https://www.cityofadelaide.com.au/about-adelaide/visitor-information/>

South Australian Museum

The South Australian Museum, founded in 1856, is on North Terrace in the City and has some excellent displays, notably the Ediacaran and opal displays, see <https://www.samuseum.sa.gov.au/> The South Australian Museum has kindly offered CAVEPS delegates **free entry in to the Australian Geographic Nature Photographer of the Year Exhibition** on presentation of your complimentary ticket. You can find your complimentary ticket in your conference swag bag.



The Art Gallery of South Australia

The State Art Gallery was founded in 1881 and is two doors down from the Museum and is in another classic 19th Century building <https://www.agsa.sa.gov.au/>

State Library of South Australia

The State Library of South Australia is the largest public research library and the digital preservation system in the state, and among the most iconic cultural institutions in South Australia. Don't miss the Mortlock Chamber, voted the 2nd most beautiful library in the world! <https://www.slsa.sa.gov.au/home>

Adelaide Zoo

The Adelaide Zoo is located in walking distance from North Terrace in the Adelaide parklands beside the River Torrens on Plane Tree Drive. There is a large colony of Grey-headed flying foxes just outside the gates that established in 2010. <https://www.adelaidezoo.com.au/>

Adelaide Botanic Garden

A couple hundred metres from the Zoo is the small but excellent Botanical Gardens. It features numerous garden types and an excellent cafe <https://www.botanicgardens.sa.gov.au/visit/adelaide-botanic-garden>

Adelaide Central Market

With over 70 traders under one roof, the Adelaide Central Market (established in 1869) is one of the largest undercover fresh produce markets in the southern hemisphere, buzzing with life and colour all year round. The Market offers a huge range of fresh food including fruit and vegetables, meat and poultry, seafood, cheeses, bakery, smallgoods and health foods, along with some of Adelaide's most popular cafes and eateries. <https://adelaidecentralmarket.com.au/about/>

Flinders University Museum of Art

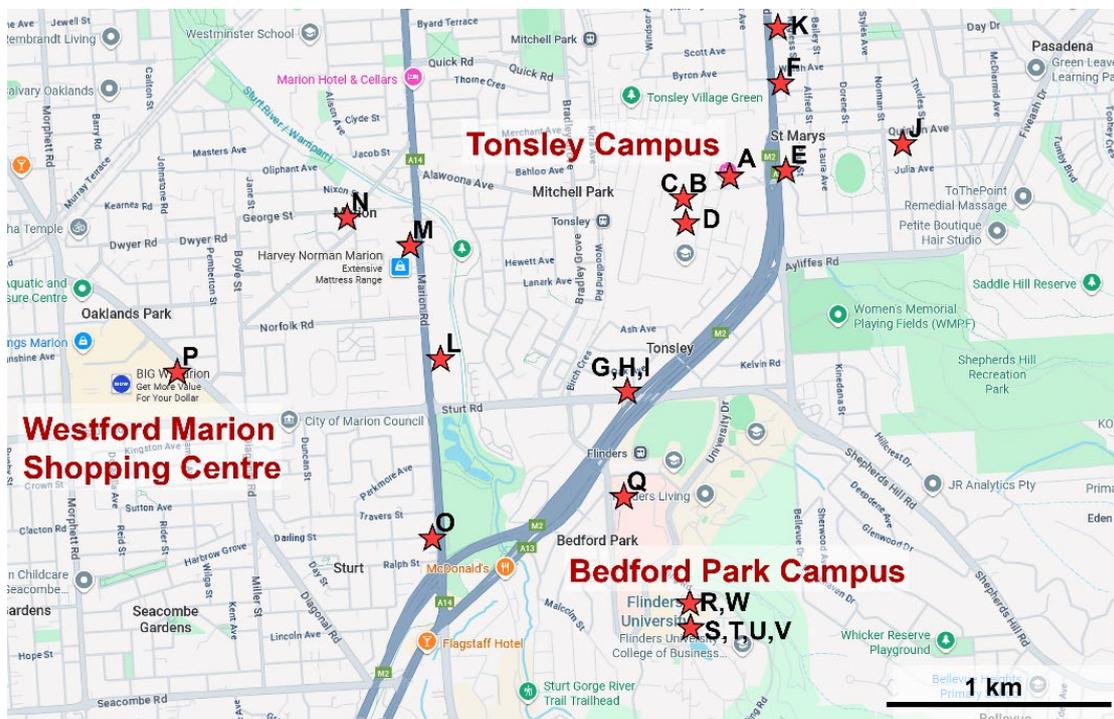
FUMA is just a short trip on the loop bus over to the Bedford Park campus—perfect for a lunchtime visit. The exhibition *ngaratya (together, us group, all in it together)* brings together stunning new works by six Barkandji/Barkindji artists who have aspired as a group to make Barkandji/Barkindji Country an active participant in their project. Free entry. Please check here for information and opening times <https://www.flinders.edu.au/museum-of-art/exhibitions/ngaratya> and here for how to get there <https://www.flinders.edu.au/museum-of-art/visit>

Day trips

A plethora of options, including local wine regions of McLaren Vale, Adelaide Hills, Barossa and Claire Valley. Also Kangaroo Island, and other southern beaches such as Port Noarlunga, Port Willunga, Carrickalinga and all the way down to Victor Harbour.

Food and drink

A light morning and afternoon tea will be available for registered delegates at the main entrance. Below are some reliable options for food and beverages, with emphasis on good lunches and coffee!



- A. Mantra Tonsley Bar Bistro, 2 MAB Cct, Tonsley - **Delegate Lunch Offer Enjoy 15% off food and beverage Monday to Friday | 12:00pm – 2:00pm.** Available upon presentation of your CAVEPS badges.
- B. Sakura Sushi, C8 MAB, 6 MAB Eastern Prom, Tonsley
- C. Three Little Pods, D9 MAB, 6 MAB Eastern Prom, Tonsley
- D. Funk Coffee+Food, 1284 South Rd, Tonsley. 10% discount at Funk Tonsley on presentation of conference badge.
- E. The Southern Bar Gaming Bistro, 1303 South Rd, St Marys
- F. St Mary's Snack Bar, 1269 South Rd, St Marys
- G. Desi Pakwaan, 372 Sturt Rd, Clovelly Park
- H. Oppa Eatery, 382 Sturt Rd, Tonsley
- I. Nammi Vietnamese Sturt Road, 384 Sturt Rd, Tonsley
- J. Vincenzdough, 4A Stanlake Ave, St Marys
- K. Master Chef Indian Tandoori, shop 2/1249 South Rd, St Marys
- L. Subway Mitchell Park, shop a/941-945 Marion Rd, Mitchell Park

- M. D.OSE, 808 Marion Rd, Marion
- N. Café Finnis, 28b Finnis St, Marion
- O. Sturt Pizza, Shop 4/930 Marion Rd, Sturt
- P. KFC Marion Mall Food Court, Food Court, Marion Mall, level 2/297 Diagonal Rd, Oaklands Park
- Q. Theo's Coffee Lounge, Flinders Medical Centre, Flinders Dr, Bedford Park
- R. Grind & Press, Bedford Park
- S. Flinders Tavern, 1 Student Hub Flinders University, Sturt Rd, Bedford Park
- T. Mr Wuhu Flinders University, Flinders University, Bedford Park
- U. Subway, Flinders University, Plaza and Student Hub, Tenancy 3 Registry Rd, Bedford Park
- V. Toly Vietnamese, Flinders University, Plaza and Student Hub, Tenancy 3 Registry Rd, Bedford Park
- W. Cafe Bon Voyage, Flinders Laneway, Bedford Park

Make your **mark**
 at Australia's
 most aspirational
 Museum of
 Natural History



Scientific program

Workshops – Monday 24 November

The Workshops will focus on an introduction to and practical application of advanced palaeontological and biological analyses. They will be taking place at a variety of venues across the Tonsley and Bedford Park Campuses.

Workshop 1: Submitting to high-profile scientific journals – how to increase your chances in the lottery, from Professor MIKE LEE.

Duration: 90 mins. Places: 30. Cost: Free. Location: Tonsley Collaborative Space 1.08, 11am-12:30.

Some of the most prestigious scientific journals have acceptance rates of <0.05 , which (to a frequentist) means your paper is certain to be rejected. Mike Lee www.michaelsylee.wordpress.com/ will share his 20+ years of experience of publishing in top journals and provide advice on how to increase your chances in this competitive environment. We'll discuss how to write and pitch the paper for maximum impact, how to survive editorial filtering (desk rejections), navigating the reviewer process (e.g. how to avoid your enemies), and how to deal with tricky reviewer comments. This will be an interactive workshop, so please come with questions and problems!

Workshop 2: Media training workshop, from ADELE PENTLAND and SALLY HURST.

Duration: 120 mins. Places: 60. Cost: Free. Location: Tonsley Conference Space 5.29, 9-11am.

Effective science communication is an essential skill that helps researchers connect with the public, funding bodies, and decision-makers — but it's rarely taught during formal academic training. This interactive workshop will provide practical guidance on how to craft compelling messages for the media, write engaging press releases, and prepare for live and pre-recorded interviews. Participants will also learn how to collaborate with institutional media teams, pitch articles to platforms like The Conversation, and use social media to boost the visibility of their research. The workshop is suitable for students, early-career researchers and senior academics alike. The workshop will be facilitated by Adele Pentland (Curtin University) and Sally Hurst (Macquarie University), both Superstars of STEM with extensive experience in public engagement and media communication.

Workshop 3: Where do you stand? Benchmarking research impact in Australasian vert palaeo, from A/Prof GILBERT J. PRICE.

Duration 120 mins. Places: 30. Cost: Free. Location: Tonsley Collaborative Space 1.08, 9am-10:30.

What's a good H-index? How many citations should you have? How do I sell my publication record? This workshop tackles those questions head-on. The core problem? We're constantly measured against benchmarks that don't truly exist, especially in our field. I've done the heavy lifting so you don't have to: compiling new bibliometric data tailored specifically to Australasian vertebrate palaeontology and mapping out what 'excellence' really looks like in our region and geographic setting. In this workshop I'll unpack actual citation trends, H-index trajectories, authorship patterns, and publication volume. But more importantly, I'll focus on how to use those data strategically to write stronger grant applications, craft smarter promotion cases, build your CV, and advocate for the impact of your work. This isn't a generic 'how-to' metrics session. It's purpose-built for researchers working in or around vertebrate palaeontology across Australia, Aotearoa New Zealand, and our regional neighbours, from students to ECRs, mid-career to seasoned pros, whatever your current track record. This workshop will provide you with:

- *Field-specific benchmarks for citation and authorship metrics*
- *Practical tips for using metrics in funding and promotion contexts*
- *A sharper understanding of how metrics behave in our field, and how to make them work for you*

Bring your curiosity. This isn't just about numbers: it's about visibility, credibility, and getting the recognition your work deserves.

Workshop 4: Musculoskeletal modelling and simulation, from PETER BISHOP.

Duration: 240 mins. Places: 20. Cost: Free. Location: Tonsley Lecture theatre 2, 12-4pm.

This workshop will introduce key concepts and components of rigid-body modelling of musculoskeletal systems. You will learn about: what a musculoskeletal model is; what are the elements that make a model;

the basic steps and inputs in creating a model; the inputs required to run a simulation; what kinds of analyses and simulations are possible; strengths and limitations; and validation and sensitivity analysis. The workshop will be framed around the widely used open-source software OpenSim and will be broken into two parts. Part 1 will involve a series of short seminars on the theory and concepts underpinning musculoskeletal modelling and simulation. Part 2 will involve a series of practicals and worked examples, showcasing the OpenSim interface, how to modify a model, and how to run a basic simulation. The workshop is designed to give participants a taste of what kind of questions musculoskeletal modelling may be useful for (and what ones it may not be), and what it takes to get there. Ideally, participants will register as and attend in pairs or small teams, rather than each person working on their own separate model. Please reach out to Peter (pbishop@fas.harvard.edu) if you have questions regarding the workshop. Windows laptop and software downloads will be required.

Workshop 5: Moulding and Casting, from CAREY BURKE.

Duration: 240 mins. Places: 20. Cost: \$33. Location: Biology Discovery Centre labs 1&2, off Carpark 8, Bedford Park campus.

This is an introductory workshop intended for those folk who have little or no experience with replicating fossil material. During the workshop we will create two different styles of small silicon moulds and discuss the pros and cons of each style. We will then cast these in polyurethane resin and the attendees will be able to take both mould and cast items home. During the workshop there will be ample opportunity to discuss when and why to cast fossils and to explore other materials and methods of replicating specimens.

Workshop 6: Best Practices in Collaborating with Indigenous Peoples for Palaeontologists, with the DECOLONISING PALAEOLOGY WORKING GROUP.

Duration: 180 mins. Places: 60. Cost: Free. Location: Tonsley Collaborative Space 1.08 + 1.09 (or 5.29 Conference Space), 1-4pm.

The focus of this workshop is the process of building genuine collaborations with Traditional Owners and Tangata Whenua. Come and join us for a yarning circle (a safe space to share and exchanging ideas and experiences) featuring a wide range of researchers, from those with decades of experience in working alongside First Nations communities through to those navigating their first steps on this journey. Listen to other researchers' stories, contribute your own, ask questions and join in exchanging ideas and information. Yarning will be based on areas of interest of the attendees and potential topics include: understanding other ways of being, knowing and doing and how it can apply to palaeontology; determining the best points of contact when first proposing a partnership; free, prior and informed consent; different options for documenting agreements; engaging in truth-telling discussions; Traditional Ecological Knowledge (TEK) and cultural knowledge; Indigenous Cultural and Intellectual Property (ICIP); and ways on how to include support for Traditional Owner/Tangata Whenua in grant applications. Learn about the draft CAVEPS 'Code of Ethics' and 'Best Practices' guidelines and contribute your ideas. Hear about the newly created Community of Practice and find out how to get involved. This workshop will be presented in an informal yarning circle style where everyone is welcome to ask questions, share knowledge and ideas and participate in reflection.

Workshop 7: Science in a Blender: 3D Reconstruction and Animation, with ASTRID O'CONNOR.

Duration: 120 mins. Places: 80. Cost: Free. Location: Tonsley Lecture Theatre 2, 9-11 am.

Have you ever wanted to elevate a presentation with 3D models or simple animations? Or, have you ever seen a skeleton laid out on a table and wondered what it would look like walking, swimming, or flying around? Wonder no longer! This workshop will run you through the basics of the free, opensource 3D modelling program Blender and how to apply it in zoological and paleontological visual communications. We'll explore the controls of Blender, show some of its potential, detail why it isn't too overwhelming, and then use a couple of example fossil scans to showcase reconstruction and animation rigging processes. Then, we'll expand on the usability of these models by rendering and displaying them in Sketchfab (see Astrid's animated examples here: <https://skfb.ly/oWI8z>) and PowerPoint. If you would like to follow along with the worked examples, it would be most useful to bring your laptop along and download the latest version of Blender (free at blender.org) beforehand.

9:00	09:30	10:00	10:30	11:00	11:30	12:00	12:30	13:00	13:30	14:00	14:30	15:00	15:30
				Workshop 1: Lee. 11am–12:30 pm									
Workshop 2: Pentland & Hurst 9am–11am													
Workshop 3: Price. 9am–11am													
						Workshop 4: Bishop. 12pm – 4pm							
Workshop 5: Burke. 9am -1pm (BEDFORD PARK)													
							Workshop 6: DWPG. 1pm – 4pm						
Workshop 7: O'Connor. 9am–11am													

Speaker sessions

General Sessions – Tuesday 25 November to Friday 28 November

General sessions for spoken presentations and dedicated poster sessions will run from 25 November to 28 November. All general sessions presentations will be held in the Tonsley Theatre 1, and will be streamed in Tonsley Theatre 2 to create additional seating capacity. You will need to be in Theatre 1 if you want to ask questions. If you come to a session late, please use Theatre 2.

Presentation length is strictly **12 minutes**, with 2 minutes for questions, and 1 minute for change over. Presenters need to load their talks at the AV desk in Lecture Theatre 1 during either the Speaker Ready time 7:30 – 8:15 am on the morning of their talk or between 8:00am – 4:00pm on Monday the 24th . All talks should be saved in .ppt/.pptx format with videos embedded.

Posters should be attached to poster boards by Tuesday morning and will remain on display until Thursday morning. Posters must be removed immediately after lunch on Thursday.

Student Prizes

There will be student prizes for both spoken and poster presentations. To be eligible for the student poster prize, students must give a 1-minute presentation about their work during the Tuesday poster session. Please let us know if you would like to be removed from consideration.

Plenary Speakers

We are very pleased to welcome four speakers who have made exceptional contributions to Australasian palaeontology for plenary sessions at CAVEPS.

Prof Robin Beck (University of Salford)

After an inexplicable period of fascination with dinosaurs as a child, Robin later realized that fossil mammals were a far more interesting topic of study. He followed his undergraduate degree in Natural Sciences at the University of Cambridge (1999–2002) with an MSc at the Natural History Museum, London (2002–2003), where he was lucky enough to be involved in a major research project that produced the first comprehensive phylogeny of all living mammal species recognized at the time, using supertree methods. A speculative email to Mike Archer led to the offer of a PhD project studying weird or otherwise enigmatic marsupials and their relatives, which he undertook at the University of New South Wales (2005–2008), supervised by Mike and Sue Hand. After this, he did a postdoc at the American Museum of Natural History (2009–2011) supervised by Rob Voss, working on marsupial morphology and phylogeny, the results of which were finally

published as a major monograph in 2022. He then returned to the University of New South Wales as a DECRA postdoctoral fellow (2012–2014), focusing on fossil mammals from the early Eocene Tingamarra Local Fauna of northeastern Queensland. At the end of 2014, he moved back to the UK to take up a lectureship at the University of Salford, where he is currently Professor of Evolutionary Biology. His research remains primarily focused on mammalian evolution (with minor detours into isopods and fishes), and he has a strong interest in phylogenetic methods, particularly those that integrate fossil and molecular evidence.

Dr Jacqueline Nguyen (Australian Museum / Flinders University)

Dr Jacqueline Nguyen is an Australian Research Council DECRA Fellow at Flinders University, Adelaide, and a Scientific Officer in Ornithology at the Australian Museum, Sydney. She was previously an Australian Museum Chadwick Biodiversity Fellow after receiving her PhD from the University of New South Wales. Jacqueline's research interests include the systematics, morphology, and evolution of Australian birds, particularly songbirds. She is interested in using a combination of fossils, morphology, and DNA to gain a better understanding of the evolutionary history of birds, living and extinct. Jacqueline has described several species of Australasian fossil birds and has collaborated on phylogenomic studies to estimate the relationships and evolutionary timescale of modern birds. She also enjoys engaging with diverse audiences to raise the profile of Australian birds.

Dr Peter Bishop (Harvard University)

Peter has had a lifelong passion for palaeontology, geology and mathematics, and for sharing this passion with others. He started his career in 2007 as a high school student volunteer at the Queensland Museum, publishing his first paper in 2010 (on invertebrates, don't judge him too harshly). He gained a BAppSc (Hons) in Geosciences from QUT in 2012, completed his PhD in Evolutionary Biomechanics from Griffith University in 2017, and subsequently held post-doctoral positions at Griffith University, the University of the Sunshine Coast and the Royal Veterinary College. Since 2021, he has been a Research Fellow in the Museum of Comparative Zoology at Harvard University. Much of his research has involved integrating biomechanics with data from fossils and modern animals, using physics-based approaches to examine the adaptive significance of evolutionary changes in the vertebrate skeleton. Currently his research explores the sprawling-to-erect postural transition that took place in the ancestors of mammals, where he is using biomechanical modelling to understand the anatomical and physical factors that shaped this transition. Peter sees tremendous potential in the application of these approaches to understanding the diversity of Australasian vertebrate faunas, and their utility as powerful vehicles for education and science communication.

Mr David Elliott OAM (Australian Age of Dinosaurs)

David Elliott is the Executive Chairman and co-founder of the Australian Age of Dinosaurs Museum of Natural History in Winton, Queensland. His journey in Australian palaeontology began in 1999 with the discovery of a dinosaur bone on Belmont Station, sparking a significant excavation effort in 2001 that revolutionised fossil excavation techniques. Alongside his wife Judy, David founded the Australian Age of Dinosaurs in 2002, aiming to preserve the region's significant dinosaur fossils. Since then, he has led numerous excavations, uncovering new species and significantly contributing to our understanding of prehistoric life. His contribution to regional sustainability through the development of palaeotourism has led to recognition as Australia's Local Hero in 2024 and a Queensland Great in 2025. With the Australian Age of Dinosaurs now home to Australia's most significant collection of Australian dinosaur fossils, David is preparing for the final stage of the Museum – a world-class Museum of Natural History. This future landmark will serve as a central hub for Australian paleontological research and discovery, elevating our understanding of the past and inspiring future generations of scientists and enthusiasts alike.

Schedule

Tuesday 25th		
07:30-8:15	Speaker Ready	
08:15	Introduction	Alice Clement
8:30-9:15	PLENARY	Robin Beck: Major remaining problems in metatherian systematics and potential ways forward
	Session Chair	Aaron Camens
09:15	Natalie Warburton	Sexual dimorphism and allometric patterns in the craniodental morphology of dasyurid marsupials
09:30	Lisa Nink	A toothed platypus from the Early Pleistocene of southeastern Australia
09:45	Arthur I Crichton	Continental mammalian biochronology and late Oligocene marsupial turnover
10:00-10:45	Morning Tea	
	Session Chair	Aaron Camens
10:45	Matt J Phillips	Late Miocene–Pliocene diversification of macropodines and broader turnover among marsupial terrestrial herbivores
11:00	Harry Anderson	Palaeoecological investigation of <i>Diprotodon optatum</i> using strontium, carbon, and oxygen isotopes
11:15	Adam Yates	**UNDER EMBARGO**
11:30	Corbin Smithson	Shape analysis of scincid fossils from the Pleistocene of Wellington Caves (NSW, Australia)
11:45	Isabella Donato	A taphonomic analysis of the fossil lizards from Blanche Cave, Naracoorte Caves (South Australia)
12:00	Stephen F Poropat	The first Australian rhynchocephalian...?
12:15-13:15	Lunch	
	Session Chair	Kate Trinajstić
13:15	Corinne L Mensforth	Making waves in the fish-tetrapod transition: non-destructive imaging techniques facilitate a deep dive into the tetrapodomorph fishes
13:30	Charlie Boocock-Yee	Ancient fish and a lost lake: Reconstructing a New Zealand Miocene ecosystem using otolith geochemistry
13:45	Ramon Fritzen	Digital analysis reveals high morphological disparity in the Devonian lungfish <i>Chirodipterus australis</i> (Sarcopterygii: Dipnoi)
14:00	John A Long	Gogo Formation paleoecology: fauna and trophic relationships on an ancient Late Devonian stromatoporoid reef
14:15	Mackenzie J Enchelmaier	An exceptionally preserved lungfish from the Winton Formation, Queensland, Australia.
14:30-15:15	Afternoon Break	
	Session Chair	Caitlin Mudge
15:15	Aubrey Keirnan	Do migratory parrots pack light for their domestic flights?
15:30	Nicolas J Rawlence	Ancient DNA and morphometrics reveal a new species of extinct insular shelduck from Rēkohu Chatham Islands
15:45	Sally Hurst	Found a Fossil? Enhancing public awareness and protection of Australia's vertebrate fossil heritage beyond museums
16:00-18:00	Poster Session	
Wednesday 26th		
07:30-8:15	Speaker Ready	
08:15	Introduction	
08:30-9:15	PLENARY	Jacqueline Nguyen: Australia's key role in the evolution of songbirds.
	Session Chair	Trevor Worthy
09:15	Karl M Lenser	Re-evaluation of birds in the Australian Quaternary fossil record reveals greater diversity than previously recognised
09:30	Pascal Lubbe	Ancient DNA and phylogeography of the world's largest eagle, the extinct Haast's eagle (<i>Hieraetus moorei</i>) of Aotearoa New Zealand
09:45	Vanessa L De Pietri	Early Cenozoic avian diversity in New Zealand: 40 years of discovery in the Waipara Greensands
10:00-10:45	Morning Tea	

	Session Chair	Arthur Crichton
10:45	Grant A Gully	Scratches and pits on the road to understanding the evolution of mega-marsupial diets using dental microwear.
11:00	Rachel C Oertel	A new Miocene–Pliocene genus sheds light on the origins of rock-wallabies and pademelons
11:15	Sam D Arman	More macropodid microwear
11:30	Kenny J Travouillon	New fossil koala (Marsupialia: Phascolarctidae) from the Pleistocene of Western Australia.
11:45	Tiah L Bampton	Isotopic insight into the diets and ecology of a Late Pleistocene mammal community from Naracoorte, South Australia.
12:00	Julien Louys	New sites, chronology, and palaeoecological insights from the flooded cave deposits of Mt Gambier
12:15-13:15	Lunch	
	Session Chair	Ramon Fritzen
13:15	Austin N Fitzpatrick	The exceptionally preserved fish of the Devonian billabong of Canowindra, NSW
13:30	Gavin Young	The oldest known backbone?
13:45	Kate Trinajstić	The feeding behaviour of a large apex predatory arthrodires <i>Dunkelosteus</i> from the Late Devonian (Famennian) Cleveland Shale, Ohio
14:00	Lachlan J Hart	Temnospondyl body mass — why do we care?
14:15	Christina A Nielsen-Smith	Marine vertebrate assemblage and trophic interactions of the Early Cretaceous (Aptian–Albian) Eromanga Basin
14:30-15:15	Afternoon Break	
	Session Chair	Tiah Bampton
15:15	Lochlan A Patterson-Crisp	Bite club: canine tooth structure and function in aquatic mammals
15:30	Riya G Bidaye	Tooth root morphology indicates differential occlusal force dispersal in Dasyuromorphia and Carnivora
15:45	Chloe Karafilis-Brown	Devils in the west: Comparative shape analysis of fossil and modern <i>Sarcophilus harrisii</i> skulls
16:00	Isaac A R Kerr	Insights into the life history of the giant fossil kangaroo <i>Protemnodon viator</i> from an articulated mother with pouch joey
16:15	Rex Mitchell (Vera Weisbecker)	Sizing up bite force allometry: Integrating the mechanical impact of cranial size on comparisons of absolute bite force
16:30	Gilbert J Price	Megafauna at the water's edge: A Late Pleistocene <i>Diprotodon</i> site and extinction insights from the Pilbara, Western Australia
16:45	Kailah M Thorn	The subfossil fauna of Goat Cave and Prostate Pit Cave, Mundrabilla Station, Nullarbor Plain, Western Australia
17:00	Lucy I Stokes	A new Plio-Pleistocene fossil water-rat (<i>Hydromys</i>) from Barrow Island, Western Australia
17:15	Kenny Travouillon & Nic Campione	CAVEPS hosted by AAP proposal
Thursday 27th		
07:30-8:15	Speaker Ready	
08:15	Introduction	
08:30-9:15	PLENARY	Peter Bishop: The makings of a mammal: integrating the fossil record, anatomy, physics and computer simulation to provide new insights on synapsid locomotor evolution.
	Session Chair	Gilbert Price
09:15	Astrid T O'Connor	Building flippered friends in 3D: Mathematical modelling morphing madness!
09:30	Jacob D Van Zoelen	A review of the diprotodontid marsupials of New Guinea and their locomotory adaptations
09:45	Laura A B Wilson	Bone microstructure supports a Mesozoic origin for an amphibious lifestyle in monotremes (Mammalia)
10:00-10:45	Morning Tea	
	Session Chair	Pascal Lubbe
10:45	Tim Niederer	New flamingo fossils from the Oligocene of central Australia illuminate the early evolutionary history of Phoenicopteriformes

11:00	Jacob C Blokland	Oldest crown group rails and other rail-like birds (Gruiformes, Ralloidea) from the late Oligocene of central Australia
11:15	Phoebe L McInerney	It's the little things: an exceptional case of vestibular apparatus shape and relative size in Australia's avian giants, the Dromornithidae (Aves)
11:30	Ray M Chatterji	Geometric morphometrics enables accurate predictions of paleoecology and reveals unique adaptations to an expanded niche space in extinct waterfowl
11:45	Abi H Crane	More moa than ever before? New insights from the sparse pre-Quaternary fossil record of Dinornithiformes
12:00	R Paul Scofield	A new pelagornithid from the Selandian of New Zealand
12:15-13:15	Lunch	
	Session Chair	Tim Ziegler
13:15	Ian Sobbe (presented by Gilbert Price)	Where does Neds Gully stand in the Australian megafauna extinction debate? Latest findings from a critical Late Pleistocene site
13:30	Timothy J Churchill	A new genus of dasyurid from the early Miocene deposits of the Riversleigh World Heritage Area, northwestern Queensland
13:45	Antonia Parker	A new species of dactylopsiline possum (Diprotodontia: Petauridae) from the Oligo-Miocene deposits of the Riversleigh World Heritage Area, Queensland
14:00	Mathieu Duval	Non-destructive analyses in palaeontology, an illusion? On the impact of mCT scanning on fossils
14:15	Riversleigh Medal / Presentation	
14:30-15:15	Afternoon Break	
	Session Chair	Kailah Thorn
15:15	Cate Sexton	Roll the Rs in Warraty: innovative human activity inferred from vertebrate faunal remains in northern South Australia (Adnyamathanha Yarta, c. 47–10 ka)
15:30	Matthew C McDowell	The original mammal fauna of the Nullarbor Plain was decimated when Europeans colonised Australia
15:45	Caitlin Mudge	Mitochondrial genomes clarify the historical range and population history of the Plains Mouse (<i>Pseudomys australis</i>)
16:00-17:00	Panel	Decolonising Palaeontology Working Group
Friday 28th		
07:30-8:18	Speaker Ready	
08:15	Introduction	
08:30-9:15	PLENARY	David Elliot: Australia's greatest untold story: Building a monument to the geological journey of our continent.
	Session Chair	Astrid O'Connor
09:15	Mathew C Herne	New findings on the cranial anatomy, neuroanatomy and palaeobiology of <i>Muttaburrasaurus langdoni</i> Bartholomai & Molnar, 1981: a large-bodied ornithomimid from the mid-Cretaceous of Australia
09:30	Jake Kotevski	Revised osteology of <i>Australovenator wintonensis</i> Hocknull <i>et al.</i> , 2009, Australia's most complete non-avian theropod dinosaur
09:45	Adele H Pentland	A new unusual crested anhanguerian (Pterosauria, Pterodactyloidea) from the late Early Cretaceous Toolebuc Formation, Eromanga Basin, Australia
10:00-10:45	Morning Tea	
	Session Chair	Isaac Kerr
10:45	Aidan MC Couzens	Postnatal development of short-tailed opossums: Implications for metatherian life history evolution
11:00	Natasha N Tay	Comparative anatomy of the gluteal muscles in marsupials: resolving homology and nomenclature
11:15	Gavin J Prideaux	A strange new kangaroo from the Pleistocene of southern Australia
11:30	Samantha Smith Kemp	Breaking the limits: Inclusion of extinct species increases the cranial morphological morphospace occupation of marsupial mammals
11:45	Sophie White	Multidisciplinary collaborations with collagen peptide mass fingerprinting (ZoomS) and identifying marine mammal species utilised by iwi Māori
12:00	Kliti Grice	Steroids in fossil vertebrates: Early diagenetic processes

12:15-13:15	Lunch	Wildlife encounters with Animals Anonymous
	Session Chair	Alice Clement
13:15	Zak Hayman	A new archaeolamnoid shark from the 'middle' Cretaceous of Queensland with insights into Archaeolamnidae (Neoselachii: Lamniformes) systematics
13:30	Emil Herbert	Long gone wobbegongs: A new species of orectolobiform shark from the 'middle' Cretaceous of Australia
13:45	Joshua P Batt	Rethinking early tetrapodomorph jaws: Phylogenetic synapomorphies revealed in the rhizodont fish <i>Vorobjevaia dolodon</i>
14:00	Brian Choo	Big Mouth gets a makeover. Assembly of the stem-osteichthyan body plan revealed by the Silurian fish <i>Megamastax</i>
14:15	Jayden T Cameron	New mosasaur material from the Upper Cretaceous of North Canterbury, New Zealand
14:30-15:15	Afternoon Break	
	Session Chair	Adam Yates
15:15	Rhys D Meyerkort	New leptocleidid plesiosaur from the mid-Cretaceous northwest continental margin of Western Australia
15:30	Ashlea Turner	Revisiting <i>Lapillopsis nana</i> from the Triassic Arcadia Formation of Central Queensland, Australia
15:45	Alexander H Brown	Finding that lost to time: using geometric morphometric analysis of subfossil gecko bones to reconstruct prehistoric ecological diversity
16:00	Emerson Castle	An investigation of the crocodylians of the Pliocene Tirari Formation, South Australia
16:15	Fraser Brown	Functional implications of the unusual skull of the giant Pleistocene wombat, <i>Phascolonius gigas</i> (Owen 1858).
16:30	Tim Ziegler	A Pleistocene vertebrate fossil locality informing palaeoenvironment and ecology in an unflooded Naarm (Port Phillip)
16:45	Ben Beeton	Genestreaming sculptures national tourism trial
17:00-17:30	End/Awards	

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Abstracts 2025
KEYNOTE ABSTRACTS

Major remaining problems in metatherian systematics and potential ways forward

Robin M. D. Beck

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The phylogeny of Metatheria (marsupials and their relatives) has been the subject of over a century's collective study by many different systematists. The increasing availability of very large ("phylogenomic") molecular datasets has led to the emergence of a largely resolved phylogeny of living groups, confirming the monophyly of some clades originally proposed based on morphological data, such as the currently recognised marsupial orders, and the superordinal clade Australidelphia that links the microbiotherians of South America and Antarctica with the modern Australian radiation. However, many key relationships within Metatheria remain uncertain, particularly those involving fossil groups, inhibiting our understanding of biogeography, patterns of trait evolution etc. I discuss several of the most pertinent here. Using improved molecular and total evidence clock approaches, I show that the divergence between Eutheria (placentals and their relatives) and Metatheria may be somewhat younger than currently thought, with implications for the affinities of putative middle Cretaceous eutherians. Based on molecular evidence, several nodes within Marsupialia appear to approximate "hard" polytomies, including the position of the root, and the base of Phalangerida (macropods and "possums"); drawing analogies with placental mammals, I propose that these may be correlated with major faunal turnover events, providing a new perspective on the timescale of marsupial diversification, albeit one that requires careful testing against the known fossil record. Finally, I test whether conflicts between current morphological and molecular estimates of marsupial phylogeny can be resolved by better modelling of morphological homoplasy and improvements in the fossil record, or whether progress is likely to require fundamentally new approaches.

Australia's greatest untold story Building a monument to the geological journey of our continent

David Elliott

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Australian Age of Dinosaurs Museum of Natural History, The Jump-Up Dark-Sky Sanctuary, Winton, QLD

The Australian Age of Dinosaurs Museum of Natural History is more than a museum – it is a bold celebration of Australia's extraordinary natural history. From humble beginnings in Outback Queensland, it has grown through passion and vision, proving that regional Australia can make a world-class contribution to science and palaeontology. For palaeontologists and scientists, it offers access to fossils, data and research and a chance to collaborate and advance the study of our prehistoric past. This is a museum for all Australians, particularly our children because they are the future custodians of our continent. The better they understand where it has been, the better they will understand where it is going and be able to care for it. It has never been more important that we have a natural history museum of our own.

The makings of a mammal: Integrating the fossil record, anatomy, physics and computer simulation to provide new insights on synapsid locomotor evolution

Peter J. Bishop

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Geosciences Program, Queensland Museum, Brisbane, Queensland, Australia*

The origin of mammals from non-mammalian synapsid ancestors is a textbook example of a major transition in vertebrate evolution. It was accompanied by profound shifts in many aspects of organismal biology, including a major reorganization of the locomotor system. This revolved around a shift from

‘sprawling’ to ‘erect’ limb postures, and increased functional regionalization of the vertebral column, laying the foundations for the myriad locomotor strategies employed by modern mammals. Yet, despite an exemplary fossil record, clarifying locomotor function and its evolution in extinct non-mammalian synapsids has remained challenging. Taking an integrative approach—synthesizing the fossil record, extant animal anatomy, in vivo experiments and computational biomechanics—has the potential to provide new and quantitative insights on various aspects of the problem. This presentation will summarize recent work on that front, addressing synapsid locomotion at multiple anatomical scales, from individual bones and muscles through to limbs and whole-animal gait cycles. Far from the classical, orderly narrative, the ‘sprawling-to-erect transition’ in synapsids is increasingly becoming understood as a highly complex, nonlinear and protracted event. Some mammalian anatomical (muscular) traits are not just far more ancient than previously believed but likely reflect the ancestral amniote condition better than other extant groups. Structural transformation of limb bones was dotted with mosaicism and instances of evolutionary trend reversal. A fully erect (therian-like) limb posture evolved much later than originally thought, well within crown mammals. And anatomical and functional transformation of the forelimb, hindlimb and vertebral column were intricately coupled to one another. The development and application of novel analytical and computational approaches during this research has greatly refined our understanding of synapsid evolution. Excitingly, these approaches also have great potential for unlocking the diverse functional and behavioural mysteries of extinct Australasian vertebrate faunas.

Australia’s key role in our understanding of songbird evolution

Dr Jacqueline Nguyen

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Songbirds (Passeriformes: Passeri) form the largest and most diverse radiation of living birds, comprising nearly half of the world’s avifauna. With over 5,000 species, songbirds include familiar species such as honeyeaters, magpies, ravens, finches, and sparrows. They have successfully adapted to a wide range of foraging niches and occupy all vertical strata, from the ground to the upper canopy and skies, and are found in almost every habitat and continent. In recent years, genetic and genomic studies have shed considerable light on the evolutionary history of songbirds. These molecular studies have transformed our understanding of the avian ‘tree of life’, including the unexpected finding that almost half of the world’s birds can trace their origins back to an ancestor in what is now Australia. Despite the enormous diversity and ubiquity of songbirds today, there is still much to learn about their early fossil record and how they became so successful. In this presentation, I will illustrate how the Australian fossil record, in partnership with genomic analyses, has been used to understand the early history of songbirds and the evolutionary relationships among modern birds.

ABSTRACTS FOR TALKS AND POSTERS

Posters are denoted by *; Student presentations by §.

§Palaeoecological investigation of *Diprotodon optatum* using strontium, carbon and oxygen isotopes

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Megaherbivores are keystone species, with their environmental interactions significantly impacting the ecosystems they inhabit. *Diprotodon optatum* was the largest marsupial to have ever lived and had a near continent-wide distribution. Understanding the behaviour and ecology of *Diprotodon* is critical for understanding the dynamics of Australia's late Pleistocene environments. In this study, an ever-growing upper incisor of an adult *Diprotodon* from Lake Callabonna was serially micro-sampled, yielding high-resolution geochemical data. Using a combination of strontium (Sr), carbon (C), and oxygen (O) isotopes, the movements, landscape usage, and dietary history of this individual were investigated. Enamel $^{87}\text{Sr}/^{86}\text{Sr}$ ratios were compared to a bioavailable soil $^{87}\text{Sr}/^{86}\text{Sr}$ isoscape, revealing that this individual did not stay exclusively at Lake Callabonna, with 60% of the $^{87}\text{Sr}/^{86}\text{Sr}$ values outside the local signal range. The $\delta^{13}\text{C}$ values indicate that this *Diprotodon* consumed a mix of C_3 and C_4 browse, and the $\delta^{18}\text{O}$ values suggest this individual was an obligatory drinker living in a relatively arid environment. Cyclical, seasonally-driven patterns were observed in the $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ values, allowing for a recalculation of the tooth growth rate which suggested that an adult *Diprotodon*'s upper incisor represents 10 years of growth. These patterns were not observed in the $^{87}\text{Sr}/^{86}\text{Sr}$ ratios, suggesting that resource-driven migratory behaviour was not exhibited by this *Diprotodon*. Factors such as topography and surface water availability were likely the prominent dictators of landscape use. The contrasting and overlapping interpretations of *Diprotodon* parallels other megaherbivores, whose large body-size and generalist diets allow for the exhibition of a wide range of behaviours to suit environmental conditions. The highly adaptable nature of *Diprotodon* necessitates the study of more specimens using a combination of analytical techniques to further elucidate the full palaeoecological role of this influential megaherbivore.

More macropodoid microwear

Samuel D. Arman¹, Grant A. Gully and Gavin J. Prideaux

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¹Megafaunal Central, Museum and Art Gallery of the Northern Territory, Alice Springs, NT

Dental microwear texture analysis (DMTA) quantifies microscopic surface features on tooth enamel, allowing researchers to infer past diets. In Australian palaeontology, this has principally been applied to kangaroos as the most speciose vertebrate herbivores, to better understand the late Pleistocene extinctions of many species. This work is now being extended to multiple other sites across Australia to provide a broader platform for dietary comparison. The dataset is heavily biased towards more recent species, helping refine our understanding of Australian ecosystems in the lead up to Pleistocene extinctions and more recent changes to the landscape. For a small number of species, we are even able to assess differences between localities to question whether we can detect geographic or temporal variation in diet. For many others, this dataset presents the first chance to attain a direct measure of diets, including basal macropodine and sthenurine species, to better understand what role broader environmental change played in the evolution of this group. As always however, this analysis raises more questions than answers, but in doing so points to prospects for improving our understanding of DMTA methods and kangaroo ecology.

§Isotopic insight into the diets and ecology of a Late Pleistocene mammal community from Naracoorte, South Australia

Tiah L. Bampton, Elizabeth H. Reed, Lee J. Arnold, Martina Demuro, Larisa DeSantis and Steven J. Bourne
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Investigating palaeoecology on a community scale can help elucidate individual life habits and the association of species with their environments, which can help understand drivers of species decline and extinction. Stable isotope analysis of carbon ($\delta^{13}\text{C}$) and oxygen ($\delta^{18}\text{O}$), derived from mammalian tooth enamel, is a globally recognised proxy for obtaining semi-quantitative results of past mammalian dietary preferences and their drinking behaviours. The pristine fossil deposits within the extensive karst system of the south-east of South Australia, have given insight into the palaeoecology of Quaternary faunas and community responses to changes in climate over the last 500 thousand years. Komatsu Cave, in the Naracoorte region, covers a relatively brief window of time, dating to the marine isotope stage 4 to 3 transition. We analysed stable isotopes of carbon and oxygen from the bioapatite of fossilised enamel representing a suite of large- and small-bodied mammal species including: extinct megafaunal species ('*Procoptodon*' *gilli*, *Zygomaturus trilobus* and *Thylacoleo carnifex*), macropods (*Notamacropus greyi*, *Notamacropus rufogriseus*, and *Macropus fuliginosus/giganteus*), wombats (*Lasiorhinus* spp.), bandicoots (*Perameles* spp.), potoroids (*Potorous* spp. and *Bettongia* spp.), and rodents (*Mastacomys fuscus*, *Pseudomys* spp.). Our aim was to use these data to reconstruct past ecology and community dynamics of the Komatsu Cave faunal assemblage to gain information on the drivers of species decline and extinction. The broad range of $\delta^{13}\text{C}$ values indicates diverse resource use and species level niche partitioning, while relatively narrow ranges in $\delta^{18}\text{O}$ values indicates water source. This study, when compared to previous stable isotope studies, shows consistent dietary preferences and drinking sources and behaviours, while elucidating new isotopic palaeoecological records. The combination of stable isotopes with the temporally constrained assemblage within Komatsu Cave, provides insight into palaeoecology and life habits of these animals in a way that has yet been explored at Naracoorte and comparable sites in Australia.

§Rethinking early tetrapodomorph jaws: Phylogenetic synapomorphies revealed in the rhizodont fish, *Vorobjevaia dolodon*

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The tetrapodomorphs comprise a group of sarcopterygian fish, some of which were the first vertebrates to transition to terrestrial environments. The group first appeared in the middle-lower Devonian, and non-tetrapod lineages persisted until the end Permian. Although many of the tetrapodomorphs did not ultimately transition to land, they remained dominant and successful aquatic predators during the Devonian and Carboniferous periods. However, the early jaw morphologies of some of these major groups are poorly known or even completely undefined, such as the case for the rhizodontids. Herein, we present our new phylogenetic analysis on the middle Devonian (Givetian), Eastern Gondwanan (Australia and Antarctica) taxon *Vorobjevaia dolodon*. *Vorobjevaia dolodon* is only known from an impression of the lower jaw and thus it has been difficult to determine its affinity to other tetrapodomorphs until recently. Using both parsimony and Bayesian inference, *V. dolodon* is consistently resolved within the rhizodontids. This is supported by several rhizodontid characters, including the presence of a sigmoid symphyseal (anterior jaw) tooth, reduced Meckelian ossification, and a squared-off anterior jaw profile. Most notably, the adsymphyseal bone of *V. dolodon* has a unique arrangement, thought to be unique to more basal tetrapodomorphs, but a re-evaluation of this bone suggests a more complex distribution. These results indicate that early rhizodontid jaws possess morphologies distinct from those of other tetrapodomorphs of the Devonian, enabling confident identification where previously dubious.

Genestreaming Sculptures National Tourism Trail

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Our team is constructing a national trail of giant evolutionary trees as public artworks that we call Genestreaming Sculptures <https://sciart.com.au/genestreaming-journey-sculptures-nation-wide-tourism-trail-an-introduction/>. We are seeking to connect with palaeontologists who are interested in sharing their research through sculptures with the broader community. In 2017, artist Ben Beeton and Noongar Elder Aunty Carol Pettersen OAM envisaged a national sculpture trail that would promote science, conservation and culture. In 2019, Ben Beeton, whilst designing virtual reality Tree of Life learning & teaching tools at the Australian National University, created a design for the sculpture that was a giant evolutionary tree of selected species specific to the region. When people enter a sculpture, they are walking back through the geological time scale and can see where humans share common ancestry with 15 selected species from a specific region. The external appearance of a sculptures features artworks from first nations artists with connections to the region. The internal art created by scientific illustrator Mali Moir and Ben Beeton with scientific and community input, features field naturalist studies of the region and its deep time origins with scientific illustrations of selected species. The foundation for any given project is to select species from the region in question and then research their shared ancestry and construct a phylogenetic tree. The research is undertaken by Gary Muir. We have developed an animated Augmented Reality version of the sculpture which provides a deeper understanding of the history of the Earth. This initiative is focused on connecting visitors with an experience of the Tree of Life through geological time, landscape origins, conservation and culture.

§Tooth root morphology indicates differential occlusal force dispersal in Dasyuromorphia and Carnivora

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Tooth roots, owing to their function of occlusal force dispersal, are excellent biomechanical indicators of dietary characteristics. In large eutherian carnivores, increasing tooth root surface area (TRSA) is demonstrably related to processing more mechanically challenging foods. This study aims to analyse the relationship between TRSA and prey characteristics in four species of the marsupial Order Dasyuromorphia and contextualise this relationship in a comparative framework of placental carnivore data. This first evaluation of the relationship between TRSA and mechanical processing in marsupial carnivores will provide a novel approach to aid in dietary and ecological interpretations of fossil Australian taxa from isolated and partial dental fossil specimens. We imaged the skulls and mandibles of *Thylacinus cynocephalus*, *Sarcophilus harrisii*, *Dasyurus maculatus*, *Dasyurus viverrinus*, fossil *Sarcophilus lanianus*, as well as those of medium-sized placental carnivores (Order Carnivora, various families) using computerised tomography. These scans were segmented and skeletal elements and individual teeth were extracted as surface meshes. The meshes were edited to isolate tooth roots, and TRSA values were recorded. We then assessed the relationships between skull size-normalised TRSA values and prey size and mechanical toughness. We found that TRSA remains a useful biomechanical indicator of dietary preferences in marsupial carnivores. However, whereas the TRSA distribution along the tooth row in eutherian carnivores shows a clear peak at the carnassial complex, a flatter, more even distribution is observed in marsupials. TRSA remains a useful indicator of dietary preference in fossil and extant marsupial and eutherian carnivores. Marsupial TRSA demonstrates broader biomechanical loading across the postcanine dentition, with the difference in patterns of TRSA variation along the tooth row possibly being related to differential tooth replacement between marsupials and placentals, i.e., molar progression in marsupials vs. one-to-one replacement of the carnassial in placentals).

§Oldest crown group rails and other rail-like birds (Gruiformes, Ralloidea) from the late Oligocene of central Australia

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Rails (Rallidae) are an ecologically diverse, widespread, and speciose family of predominately wetland-associated birds. Their superfamily Ralloidea also includes the rail-like flufftails (Sarothruridae), Caribbean rails (Nesotrochidae), aquatic finfoots (Heliornithidae), and aberrant adzebills (Aptornithidae). Phylogenomic studies have revised the taxonomic and phylogenetic affinities of recent raloids, suggesting crown group Rallidae originated in the late Eocene. However, the affinities of pre-Pliocene fossil taxa are poorly understood, stemming from their generalist and relatively homogenous skeletons, widespread homoplasy, and limited fossil material. The late Oligocene Etadunna and Namba Formations of the Lake Eyre Basin, South Australia, contain abundant raloid fossils comprehensively assessed here. Three species coexisted in the Pinpa Local Fauna (LF), from the Namba Formation, including *Australlus disneyi*, otherwise known only from the Riversleigh World Heritage Area, Queensland, ~1600 km northward. Of the other two taxa, the most common also occurs at Lake Yanda (Yanda LF), and both species are found at Neville's Nirvana, Lake Palankarina (Minkina LF). Raloid fossils in Etadunna Formation sites are rare; one additional taxon derives from the Tedford Locality (Ditjimanka LF), and another from Mammalon Hill (Ngama LF) where it co-occurred with the more common of the older taxa. The older, well-represented species were analysed in a parsimony and Bayesian framework using a new detailed osteological character matrix (599 characters), and a molecular-based scaffold for a broad sample of modern gruiforms. Two taxa were recovered as generalist basal members of the two subfamilies of Rallidae and represent the oldest demonstrably crown group rails. Contrary to prior phylogenetic study, *Australlus disneyi* is shown to be non-rallid, more closely related to Heliornithes within Ralloidea. The generic diversity of raloids in the late Oligocene of Australia remains much lower than in the Holocene, suggesting their larger representation in modern faunas resulted from more recent adaptive radiations, consistent with molecular diversification estimates.

*§ Phylogenomics of Macropodidae clarifies relationships of *Protemnodon* and *Simosthenurus* and reveals ancient introgression

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Most Australian megafauna went extinct ~60–40,000 years ago, including the giant kangaroos *Protemnodon* and *Simosthenurus*. Their evolutionary relationships to other kangaroos and wallabies based on morphological and limited molecular evidence remain debated. In particular, ancient mitochondrial DNA previously obtained from specimens from Mount Cripps, Tasmania, can be misleading under scenarios of hybridisation or rapid radiation. We assembled a phylogenomic dataset comprising exome-derived genetic markers from living and recently extinct macropodids, combined with whole nuclear genomes for *Protemnodon* and *Simosthenurus*, aligned to a tammar wallaby reference genome. Our aims were to i) resolve the placement of *Protemnodon* and *Simosthenurus* within Macropodidae, and ii) identify introgression events among macropodid lineages. Maximum-likelihood trees were constructed with RAxML-NG, genetic affinities were quantified using *f*-statistics, and introgression scenarios were tested with qpGraph. The phylogenetic trees recovered positions for the giant kangaroos congruent with mitogenomic results: *Protemnodon* is closely related to the *Macropus* complex (true kangaroos and wallabies) and *Simosthenurus* is closely related to *Lagostrophus fasciatus* (banded hare-wallaby). However, we detected unexpectedly strong genetic affinity between *Lagorchestes* (hare-wallabies) and *Onychogalea* (nail-tail wallabies). Admixture graph-based modelling supports a pulse of gene flow from *Onychogalea* into the *Lagorchestes* lineage prior to diversification within hare-wallabies. These results provide definitive placement of the Late Pleistocene giant kangaroos within Macropodidae using genomic data and reveal previously unrecognised ancient introgression shaping hare-wallaby evolution.

§Ancient fish and a lost lake: Reconstructing a New Zealand Miocene ecosystem using otolith geochemistry

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Ancient DNA analysis of the recently extinct amphidromous upokororo New Zealand grayling (*Prototroctes oxyrhynchus*) has shown that its ancestors likely colonised the archipelago up to 23 million years ago. This is consistent with the presence of two fossil grayling species in the Miocene-aged Bannockburn Formation in Central Otago: *P. vertex* and *P. modestus*. However, it is not known whether these Miocene grayling in the palaeolake Manuherikia were amphidromous or landlocked. To answer this question, my MSc research will investigate how incremental and trace chemical analysis of fossil otoliths can be used to reconstruct aspects of this Miocene ecosystem. I will conduct x-ray fluorescence, incremental, and trace element analysis (using ICP-MS and focusing primarily on strontium) of fossil otoliths of the common *P. vertex* ($n = >40$) and the rare *P. modestus* ($n = 10$), and compare these to modern analogues, to reconstruct lake seasonality, fish growth curves, population structure, and migration patterns. In addition, I will also analyse contemporaneous fossil otoliths of Eleotridae and Galaxiidae ($n = 25$ each) to test for species-specific and environmental signals. This analytical toolkit will help determine whether the Miocene grayling were amphidromous and therefore potentially direct ancestors of the recently extinct New Zealand grayling or were landlocked and represent a ghost radiation of this group in the region. This type of research has rarely been attempted on fossil otoliths and could open exciting new avenues for palaeoecological research into the future.

§Finding that lost to time: Using geometric morphometric analysis of subfossil gecko bones to reconstruct prehistoric ecological diversity

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Aotearoa New Zealand's geckos show a high degree of contemporary species diversity in eight different genera. However, it is currently unknown how much of this diversity has been lost through human-driven extinctions; until recently, it was thought that gecko bones could only be distinguished by size, not shape, with those in the subfossil record divided into five different size classes. A previous study on maxilla showed that gecko genera can be distinguished by shape differences and that maxillae of Duvaucel's and Tohu gecko (the two *Hoplodactylus* species reflective of the *H. cf. duvaucelii* size class) have undergone rapid shape change during the Late Holocene. Frontals are the most common cranial bone preserved in the other four size classes. We evaluated whether gecko genera could be distinguished based on frontal shape, and what insights could be gained into the prehistoric diversity of geckos within the *H. cf. maculatus* size class. 2D and 3D geometric morphometric analysis of modern comparative gecko frontal bones ($n = 59$ and 57 , respectively) enabled us to distinguish seven of the currently recognised genera, excluding *Toropuku* due to a lack of specimens. Inclusion of subfossil frontals ($n = 278$) showed there were marked regional differences in where geckos clustered in morphospace, whether with the modern genera or apart from them in regions not occupied by comparative species. Future non-destructive palaeogenetic research will determine whether this represents lost species diversity or rapid shape change in still-living species.

§Functional implications of the unusual skull of the giant Pleistocene wombat, *Phascolonus gigas* (Owen 1858)

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Phascolonus gigas (family, Vombatidae) was the largest (~300–400 kg) and most widespread Pleistocene wombat. It exhibited a distinctive cranial anatomy, with broad, flattened upper incisors in marked contrast to narrow, peg-like lowers, a deep mandible, and a concave, ‘bowl-like’ depression in the dorsal surface of the cranium. The Late Pleistocene deposits of Lake Callabonna, South Australia, yielded fossil skulls of *P. gigas* in 1913, and in 1970, but a complete description of the skull of this animal has never been published. Between 2019 and 2023, skeletal material from ≥5 new individuals of *P. gigas* were collected from Lake Callabonna. This included several well-preserved crania with dental and anatomical features that suggest *P. gigas* possessed dietary adaptations distinct from other vombatids. Using this new material, we present a total account of the *P. gigas* skull to better interpret its functional anatomy. The structure of the incisors and palate support the notion of a cornified pad in the upper diastema for cropping vegetation. Traditional and digital dissections of the Southern Hairy-nosed Wombat (*Lasiorhinus latifrons*) were used as a guide for reconstructing the jaw adductors in *P. gigas* based on discernible areas of origin and insertion. Their reconstruction appears consistent with a mono-lateral mode of mastication, akin to that of extant wombats, but functionally limiting direct occlusion of the incisors. This implies that the upper incisors of *Phascolonus* may have been used in novel behaviours, perhaps relating to foraging. The large bowl-like structure in the cranium is shown to be present in every specimen known, and examination in a functional light suggests it may have aided in better aligning the jaw adductors. This strange morphology points to the unique evolution of a large-bodied bulk-feeding wombat in Pleistocene Australia.

§New mosasaur material from the Upper Cretaceous of North Canterbury, New Zealand

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Mosasaur were a diverse and globally-distributed clade of large-bodied, highly specialised marine squamates that existed from the Cenomanian to the Maastrichtian. Several species are known from New Zealand, which during the Upper Cretaceous formed part of the Weddellian Biogeographic Province—a highly connected and biologically productive region of the South Pacific. This assemblage includes the Upper Campanian species *Taniwhasaurus oweni*, a member of the subfamily Tylosaurinae, which also includes the genus *Tylosaurus*. A newly discovered specimen from the Conway Siltstone of North Canterbury, preserved within a calcareous concretion and its surrounding matrix, forms the focus of this study. Using a combination of mechanical and digital preparation techniques, including CT-scanning, all preserved skeletal elements were reconstructed and described. Two additional specimens from the region (KHM N99-1014 and CM Zfr 143) were similarly imaged for comparative purposes. The newly described specimen is referred to *Tylosaurus* based on several diagnostic features and it is distinct from regional taxa such as *T. oweni*. This identification challenges the currently supported North Atlantic Circle Basin distribution for the genus *Tylosaurus*. It provides the first definitive evidence of *Tylosaurus* in the Southwest Pacific, suggesting a wider palaeogeographical distribution than previously recognised and confirming its coexistence with the southern hemisphere-restricted *Taniwhasaurus*. Morphological comparisons indicate that this specimen belonged to a large individual, with body length estimates ranging between 11 and 12.5 m, approaching the upper known size range of mosasaurs. These findings further reinforce the status of the Weddellian Province as a region of high productivity and connectivity and suggest that New Zealand’s marine ecosystems could sustain large marine apex predators during the Upper Cretaceous.

§An investigation of the crocodylians of the Pliocene Tirari Formation, South Australia

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Compared to Australia's modern crocodylian fauna, the crocodylians of the Pliocene were both more taxonomically diverse and morphologically disparate. During the Pliocene, these large, apex predators were distributed across the continent, and within its internal waterways and drainage basins. Much of the research on these animals has centred on material from Queensland, however crocodylian fossils are also known from similar-aged deposits in South Australia. The Tirari Formation, located in the Tirari Desert east of Kati Thanda-Lake Eyre, contains a record of crocodylians from the Pliocene. This study aims to describe and characterise these fossils to determine the diversity of the crocodylians in the Lake Eyre Basin at the time, and how they changed through the epoch. The early Pliocene Mampuwordu Sand Member contains two crocodylian taxa, the medium-sized generalist *Kalthifrons aurivellensis* and the terrestrial ziphodont *Quinkana* sp. By the middle Pliocene, the Pompapillina member, however, shows that both these taxa are absent, and the Member is instead characterised by large generalist broad-snouted crocodylians. Although fragmentary, the remains of these large crocodylians are well represented in the middle Pliocene by isolated teeth and osteoderms, and by less abundant skull fragments. The most taxonomically informative of these fossils is a partial snout with characteristics consistent with the enigmatic 'Darling Downs taxon'. However, the fauna is likely more speciose than this, with possibly two taxa present. This is suggested by the identification of two morphotypes amongst the teeth and dentaries. The results of this study make clear that the inland waterways of Pliocene South Australia supported a robust community of crocodylians comparable to that of Pliocene southeast Queensland.

Geometric morphometrics enables accurate predictions of palaeoecology and reveals unique adaptations to an expanded niche space in extinct waterfowl

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Establishing the relationships between organismal phenotypes and their environment is a key component to understanding evolutionary history. Comparative evaluations of extant and extinct species can reveal how lineages have adapted to changing environmental conditions over time. However, the understanding of palaeoecologies is predicated on a robust understanding of how modern species have been shaped by adaptation. Waterfowl may present an ideal group to study adaptive evolution as much of their morphology is apparently shaped by their dietary ecology. Here we use a large geometric morphometric dataset of waterfowl combined with random forest, a supervised machine-learning algorithm, and linear discriminate analysis, to predict the dietary ecologies of nine extinct waterfowl species. We find that both model types reliably predict ecology for extinct species with well-established diets. Interestingly, we also found that the Hawaiian moa-nalo and the New Zealand *Cnemiornis calcitrans* likely occupied ecological niches no longer present in modern waterfowl as they were not morphologically or ecologically convergent with modern geese as previously asserted. Our study demonstrates that waterfowl are an excellent model group for the study of adaptive evolution and underscores the utility of predictive modelling for palaeontological studies.

‘Big Mouth’ gets a makeover. Assembly of the stem-osteichthyan body plan revealed by the Silurian fish *Megamastax*.

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Osteichthyans (bony fishes and tetrapods) comprise 98% of modern vertebrate diversity, however our understanding of their ancestral bauplan has been hampered by the sparse and fragmentary nature of their most basal fossil representatives. *Megamastax amblyodus* (“Big mouth with blunt teeth”) is a bony fish from the late Silurian Kuantu Formation of Yunnan, China, that was described in 2014 based on isolated mandibles and a maxilla. Exceeding 1 m in length, this is the largest known pre-Devonian vertebrate and likely the oldest known vertebrate apex predator. Additional specimens of *Megamastax* collected in the subsequent years have greatly improved our understanding of this taxon. Most spectacular, is a complete, articulated skull and anterior trunk which yields unprecedented morphological details of the earliest bony fishes. Initially interpreted as a basal sarcopterygian (lobe-finned fish), the neurocranium of the new specimen exhibits characters more typical of chondrichthyans and maxillate placoderms. Rows of large protrusions on the palatine and coronoids, originally interpreted as durophagous palatal dentition, are shown instead to be bases for an inner dental arcade of spinose tooth cushions. These new anatomical data reposition *Megamastax* into the osteichthyan stem-group and bridges the gap between crown-osteichthyans and enigmatic fragmentary basal taxa such as *Lophosteus*, *Andreolepis* and *Janusiscus*, shedding light on the earliest evolutionary events that shaped the anatomy of modern bony vertebrates.

A new genus of dasyurid from the early Miocene deposits of the Riversleigh World Heritage Area, northwestern Queensland

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A new diminutive (~25–35 g) dasyurid from the early Miocene deposits of the Riversleigh World Heritage Area in northwestern Queensland represents the oldest known member of the family Dasyuridae. The species is described from dentary specimens preserving a complete lower premolar and molar dentition, revealing novel premolar synapomorphies that strengthen the diagnosis of the family and will assist in the future assignment of new taxa to Dasyuridae. Phylogenetic analyses employing both parsimony and dated total-evidence Bayesian methods recover the new species as the most plesiomorphic member of the family. These analyses also place the late Miocene *Mayigriphus orbus* within Dasyuridae, confirming it as the first pre-Pliocene dasyurid described, and resolve *Urrayira whitei* from the early Pleistocene as a species of *Planigale*. *Joculusium muizoni* from Riversleigh’s middle Miocene deposits is recovered as sister to all other dasyurids, although morphological synapomorphies supporting its inclusion in the family remain weak. Together, these results corroborate previous tip–node calibrated phylogenetic studies that place the origin of Dasyuridae in the late Oligocene, alongside malleodectids and thylacinids, with dasyurids remaining relatively plesiomorphic until their diversification following the Middle Miocene Climatic Optimum under increasingly cool and dry conditions.

***§ Using taphonomic and geophysical analyses to investigate bias in the accumulation of the large fossil mammal bones at Cathedral Cave, Wellington, New South Wales**

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Taphonomic processes in caves are influenced by the cave's morphology but the presence of additional subsurface structures can make this difficult to assess. Geophysical methods such as Electrical Resistivity Tomography and Ground-Penetrating Radar are common techniques for investigating subsurface structures. Here, we apply both methods to investigate subsurface structures that may have influenced the accumulation of fossils of late Pleistocene large mammals (>1 kg) at Cathedral Cave, Wellington, NSW. Accumulation at this site has been hypothesised to have occurred via a solution pipe, however, direct evidence for the pipe is lacking. By using geophysical techniques to better characterise the cave morphology, alongside observations of taphonomic modifications on bones, we aim to resolve the mode of fossil accumulation and better understand any potential biases in the structure and composition of the large fossil mammals of Cathedral Cave. Six Electrical Resistivity Tomography lines were used to generate a subsurface profile above the cave. A dipole-dipole array was used due to its sensitivity to vertical structure. Ground-Penetrating Radar was used to locate and characterise a subsurface structure resembling a possible buried solution pipe leading into a separate cavity above Cathedral Cave. Further work should reveal if this cavity lies above the main fossil chamber and any potential bias this may have introduced if the cavity acted as a primary point of accumulation. By directly observing taphonomic traces on the bones, we find support for pitfall entrapment of the fauna and attritional damage to bone. Rodent gnaw marks were observed but there was otherwise minimal evidence of predation. We show that combining geophysical and taphonomic techniques to investigate accumulation bias can identify the size and shape of buried solution pipes, enhancing our knowledge on cave fossil accumulation.

Postnatal development of short-tailed opossums: Implications for metatherian life history evolution

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Marsupials today comprise only around 5% of living mammal species and are restricted entirely to the Americas and Australasia. Yet, in the past, marsupials and their close relatives (metatherians) were much more widely distributed and common elements of terrestrial ecosystems on many continents. The unusual mode of marsupial reproduction, wherein the young are born at an extremely underdeveloped state and suckle for an extended period, often in a pouch, has been invoked as a key factor in their relative decline. However, although all marsupials produce altricial offspring, much more so than placental mammals, there is substantial variation in life history strategy within Marsupialia. Using contrast X-ray micro-CT scanning and dissection, we examined postnatal development of the gray short-tailed opossum, *Monodelphis domestica*, a small didelphid marsupial from South America which lacks a pouch. Compared with Australidelphian marsupials possessing pouches or folds, skeletal ossification and chondrogenesis in *M. domestica* is more extensive at birth, and key precocial milestones like tarsal ossification, eye opening, body fur covering, and tooth eruption occur earlier and over a shorter period. Comparative data suggests that relative to marsupials lacking a pouch, marsupials with pouches and folds produce fewer, less developed offspring, with longer weaning intervals. Phylogenetic analysis using a range of life history transition models suggest that the pouch, and therefore an altricial life history strategy, evolved multiple times within crown-group marsupials from an ancestor which lacked a pouch. Implications of this more complex scenario of life history evolution for hypotheses of metatherian decline are considered.

§More moa than ever before? New insights from the sparse pre-Quaternary fossil record of *Dinornithiformes*

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The recently extinct moa (*Dinornithiformes*) of New Zealand represent an unusual tangent in bird evolution; not only did they grow to some of the largest body sizes in all of avian history (and get to those sizes at an unexpectedly slow rate), they are unique among archosaurs for having evolved the complete absence of forelimbs. Other than abundant Late Pleistocene–Holocene specimens, the moa fossil record is very poor. To date, the sole ancient moa specimens come from the Miocene St Bathans fauna, New Zealand's only substantial pre-Quaternary terrestrial fauna. The evidence of moa presence at this locality is tantalising; despite plentiful eggshell with moa characteristics, there are only a handful of fragments from larger bones which can be assigned to the clade. Here we conduct the first thorough investigation into the moa of St Bathans, utilising the relatively scant fossil evidence to investigate their diversity and biology. Drawing comparisons with the better understood waterfowl fossil assemblage from the locality, we suggest that there existed multiple cryptic moa species at St Bathans and that the species composition varied between fossil sites. Additionally, we describe the two most substantial *dinornithiform* bone fragments known from the site and conduct their first histological analysis, revealing that these ancient moa had already evolved the clade's unusually slow growth patterns. Our investigation shows the power of a relatively poor fossil record to provide novel insight into the untold history of a truly unique lineage of birds.

§Continental mammalian biochronology and late Oligocene marsupial turnover

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Land mammal ages (LMAs) are a biochronological timescale that uses mammalian evolutionary histories to assist in the relative dating of continental vertebrate assemblages. Whereas the LMAs of most continents have been constructed using genera, the Australian framework was initially based on species. To standardise the Australian LMAs and improve their resolution, we developed a genus-level timescale for assemblages of nominally late Oligocene–Miocene age (27.3–5.3 Ma). Five LMAs are recognised. This timescale is generally similar to the original in terms of assemblage categorisation, except in that the Camfieldian LMA is divided into two intervals. It is also more robustly defined, as the taxa that are unique to each interval are represented in a larger proportion of corresponding assemblages. The starkest transition in faunal composition is seen between the two earliest of these five intervals, the Etadunna and Wipajirian LMAs. Yet, the prevailing interpretation of magnetostratigraphic data holds that these are separated by less than 200,000 years: each of these LMAs includes an assemblage (Faunal Zones B & C, respectively, of the Etadunna Formation) that has been ascribed to magnetochron Cr7 (24.65–24.46 Ma). This suggests that the attribution of magnetochrons to the strata, minimally, above or below this biostratigraphic boundary requires re-evaluation. The Etadunna–Wipajirian LMA turnover is greatest among ground-dwelling herbivores, with near-complete genus-level replacement. Large-bodied ilariids are replaced by diprotodontoids, whereas among macropodoids, hypsiprymnodontid/potoroid-like forms with bunolophodont molars are largely replaced by presumably browsing forms characterised by lophodont molars. This turnover represents a key event in the evolutionary history of Australian marsupials, but its duration and drivers remain uncertain.

Early Cenozoic avian diversity in New Zealand: 40 years of discovery in the Waipara Greensands

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The Waipara Greensand in North Canterbury, New Zealand is a crucial Paleocene locality for understanding early waterbird evolution, offering an opportunity to study Southern Hemisphere marine avifaunas shortly after the K/Pg extinction. The first described penguins from this site were *Waimanu manneringi* and *Muriwaimanu tuatahi* and work over the last ten years has added *Sequiwaimanu rosieae*, *?Crossvallia waiparensis*, *Daniadyptes primaevus*, *Waiparadyptes gracilitarsus*, *Archaeodyptes waitahaorum*, and *Waimanutaha kenlovei*, as well as a *Kupoupou* sp. and an unnamed giant penguin. Recent collections also contain exceptional new material of *Muriwaimanu tuatahi*, including its first complete skull. In addition to these ten penguin species, the Waipara Greensand has also yielded fossils of at least another five distinct higher-level avian taxa. These include *Australornis lovei*, of uncertain phylogenetic relationships, two species of Phaethontiformes (tropicbirds) and two species of Odontopterygiformes (bony-toothed birds). The tropicbird and bony-toothed bird fossils represent the earliest record of their groups, and the tropicbird fossils are the first from the Southern Hemisphere. The penguin discoveries reveal previously unknown plesiomorphic features for the earliest penguins. Highlights include well-developed basipterygoid processes, a long hind toe, and the first preservation of gastroliths in a stem group sphenisciform. Our phylogenetic analysis places *Daniadyptes primaevus* as the most basal stem group sphenisciform currently known, followed successively by *Waiparadyptes gracilitarsus*, *Waimanu manneringi*, *Archaeodyptes waitahaorum*, *Muriwaimanu tuatahi*, and *Waimanutaha kenlovei*. These taxa all branch outside a clade formed by *Sequiwaimanu rosieae* and more crownward penguins. The Waipara Greensand fauna documents a rapid evolutionary period where selective forces primarily shaped wing, pectoral girdle, and foot morphology for wing-propelled diving. The greatly elongated, spear-shaped beak remained relatively unchanged for over 20 million years, suggesting a shift in feeding ecology later in penguin evolution. This evidence reinforces New Zealand as an important region for the origin of waterbirds, documenting multiple early Cenozoic radiations.

§A taphonomic analysis of the fossil lizards from Blanche Cave, Naracoorte Caves, South Australia

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The Naracoorte Caves World Heritage Area (NCWHA, South Australia) yields a rich record of Quaternary vertebrate fossils spanning the last 500,000 years, encompassing both the Last Glacial Maximum (LGM) and Australia's megafaunal extinction window. At Naracoorte, as in other Australian Quaternary deposits, taphonomic studies highlight mammalian taxa but other vertebrate taxa remain understudied. This study presents the first taphonomic analysis dedicated to the fossil lizards from NCWHA. We quantified the preservation features of lizard fossils from Blanche Cave, an open roof-window cave deposit, sampling across existing sedimentary units to uncover accumulation histories. The skeletal element representation (number of identified specimens; relative abundance), breakage patterns, and surface features (colouration, staining, weathering, abrasion) of diagnostic fossils were recorded. Taxonomic identifications and preservation assessments were aided by comparative osteological specimens and micro-CT scan data held at the South Australian Museum, Adelaide. Robust elements (maxilla, dentaries, proximal limbs, vertebrae, osteoderms) were preserved readily in the deposits and were most represented by the skinks (Scincidae), followed by dragons (Agamidae) and monitor lizards (Varanidae); gekkotans were not detected but are reported to live in the area today. A higher abundance of lizard fossils is observed in units 3 and 4 and corresponds to a shift to savannah vegetation; lizard fossils are also more abundant during the peak MIS 4 glacial compared to the LGM. The Blanche Cave fossil deposit is known to be primarily from nocturnal avian predator accumulation (i.e., *Tyto novaehollandiae*, *Ninox boobook*) making accumulation of the diurnal lizard families through their agency unlikely. An open roof-window cave like Blanche Cave

is also accessible for animals to naturally inhabit the cave; squamates have been observed to use the cave for refugia suggesting at least one other alternative pathway for lizard fossil accumulation.

*** When biochronology and geochronology disagree: two case studies of Pleistocene fossil localities from Western Europe**

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Over the last decades, biochronology based on large and/or small mammals has proven a very useful tool to estimate the age of Quaternary fossil assemblages, and especially in the Western Mediterranean. In combination with other methods, such as magnetostratigraphy and numerical dating, it usually enables to provide a robust and coherent chronological framework for Pleistocene archaeo-palaeontological localities. However, on some occasions, biochronological inferences may strongly disagree with the independent age control. Understanding the origin of this apparent inconsistency requires a detailed evaluation of the various sources of uncertainty that may impact, and possibly bias, the age estimation or calculation. However, other aspects are also often overlooked, such as the taphonomic history of the fossil specimens and/or site formation processes. To illustrate these issues, two recent case studies based on the Pleistocene localities of Pirro Nord (Italy) and Huescar-1 (Spain) will be discussed: at these sites, the biochronological age of the fossil assemblage appears to be much older than the numerical dating results obtained by Electron Spin Resonance (ESR) and Luminescence methods. Possible explanations will be proposed.

Non-destructive analyses in Palaeontology, an illusion? On the impact of mCT scanning on fossils

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In palaeontological (and palaeoanthropological) research, the study of fossils is conditioned by the necessity to cause minimum damage to these rare, fragile and valuable remains. In this context, micro-computerized tomography (mCT) scanning of fossils is nowadays routinely used to obtain a high-resolution 3D reconstruction of samples and create a digital archive of fossils, while enabling to access critical information about the morphology and internal structure of the specimens. Importantly, mCT scanning has been traditionally regarded as a non-destructive technique, mostly because mCT usually causes no visible damage to the fossils, which explains why it has become increasingly popular in our field. However, this perception strongly contrasts with our basic knowledge of X-rays, i.e. ionizing radiations that are known to have non-negligible effects on materials they interact with. Consequently, the present work will discuss how mCT may actually affect fossil preservation and bias geochronological results. Based on a series of experiments involving fossil and modern samples, conventional mCT instruments and a range of standard experimental conditions, we will specifically focus on the Radiocarbon and Electron Spin Resonance (ESR) methods, which are both very popular methods for direct dating of Pleistocene fossils. In particular, our results show that mCT scanning may not only significantly affect the preservation of the collagen in bones and teeth used for Radiocarbon dating, but also induce a non-negligible radiation dose in the enamel, thus artificially aging a given fossil sample dated by ESR. Consequently, we encourage the implementation of protocols to minimize the exposure of fossils to X-rays, and suggest caution regarding the systematic and unlimited use of mCT scanning in palaeontology and palaeoanthropology until we get a more comprehensive understanding of the real impact this technique has on fossils.

*§ Reconstructing a temnospondyl bonebed: Diversity and depositional context of a Permo-Triassic site near Koonya, Tasmania

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The brachyopid temnospondyl *Bothriceps australis*, first named in 1859 by Thomas Huxley, is the earliest formally described Mesozoic tetrapod from Australia. Despite its historical importance, the species has only begun to be better understood since the turn of the century. The most recent study on *B. australis* in 2011 provided modern descriptions of recently discovered cranial and axial elements. However, the ontogenetic, broader palaeoecological, and depositional context of the species remains poorly understood, which in part stems from the historic recovery of specimens without consistent stratigraphic or spatial control. A bonebed near Koonya, Tasmania, now interpreted as the likely type locality of *B. australis*, offers a rare opportunity to investigate the species within an integrated anatomical, demographic, geological, and taphonomic context. This project will reconstruct the depositional setting and palaeoenvironment of the Koonya Bonebed (KBB, Knocklofty Formation, upper Parmeneer Group), assess the taxonomic diversity of the site and confirm the dominance of *B. australis*, and examine preserved size variation to evaluate ontogenetic patterns and reconstruct a growth series. Many specimens from the site remain unprepared in the collections of the Tasmanian Museum and Art Gallery, some of which (primarily cranial material) have been scanned at the Australian Synchrotron. Specimens will be studied using a combination of traditional and digital techniques, including synchrotron-based imaging and fossil preparation. Mapping of the site using a 1×1 m grid and photogrammetry is already underway to clarify depositional architecture and fossil distribution, revealing a predominant north–south transect of fossil concentration at Koonya. The KBB represents one of the only known Permo-Triassic tetrapod bonebeds in Australia, and its potential position at the extinction boundary makes it a key data point for understanding ecosystem recovery and temnospondyl palaeobiology in Gondwana following the largest mass extinction in Earth’s history.

§An exceptionally preserved lungfish from the Winton Formation, Queensland, Australia

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Dipnoi is a well-defined clade of sarcopterygian fishes noted for unique respiratory abilities and distinctive dentition. Lungfish first appeared in Early Devonian seas, were cosmopolitan by the Late Devonian, but are represented today by six species restricted to freshwater in Africa, South America, and Australia. Mesozoic fossil lungfish are typically known only from isolated tooth plates because their poorly ossified skeletons were seldom fossilised. In Australia, all named Cretaceous lungfish taxa are based on isolated tooth plates. Although some of these taxa preserve fragmentary skull elements, they are often excluded from phylogenetic analyses as they lack meaningful cranial remains. In 2023, an exceptionally preserved lungfish specimen (AODF3167) was excavated from the Winton Formation (lowermost Upper Cretaceous, ~100–95 Ma) of northeast Australia. This is the first Australian Mesozoic lungfish to preserve a tooth plate (lower, with attached prearticular) in association with a disarticulated cranial and postcranial skeleton (including a clavicle, neural spines, ‘supraneural’ bones, fin rays, and ribs). AODF3167 therefore provides a rare opportunity to unite an Australian Mesozoic lungfish tooth plate morphology with both cranial and postcranial remains; these are typically absent or poorly preserved in post-Palaeozoic lungfish. The dentition and postcranial morphology of AODF3167 suggest that it belongs to the genus *Neoceratodus*, which includes the extant Australian lungfish *Neoceratodus forsteri*. This genus is often included in phylogenetic analyses as a Cretaceous taxon, albeit with character scores based on Recent specimens. AODF3167 will enable *Neoceratodus* to be scored as a Cretaceous taxon, from a Cretaceous fossil. The discovery of AODF3167 has direct implications for understanding lungfish palaeobiogeography, ecology, and long-term evolution. By contextualising the genus *Neoceratodus* against the 100 million years of

climate change through which it has persisted, a better understanding of the vulnerability of the modern *N. forsteri* to rapid ecological change in Australia will be gained.

§The exceptionally preserved fish of the Devonian billabong of Canowindra, NSW

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The Late Devonian Canowindra billabong, a 363-million-year-old mass death assemblage preserving a rich fauna of more than 3000 individuals on a single bedding plane, lies some 10 km southwest of the township of Canowindra, NSW. Seven species of fossil fish are described from the site: five sarcopterygians (lobed fin fish) and two species of placoderm (armoured fishes). Following the rediscovery of the site in 1993 by the late Dr Alex Ritchie, most work on the site was conducted in the late 90's and early 2000's, with a recent resurgence in research interest focusing on aspects of the Canowindra billabong's palaeoclimate and palaeoecology. There is an additional, but undescribed, species of the arthrodiran placoderm genus *Groenlandaspis* Heintz, 1932. Material of this new species consists of complete articulated armours as well as numerous disarticulated bones showing external and internal morphology. Two individuals show tail impressions, with one possibly exhibiting rarely-preserved vertebral elements. Individuals of *Groenlandaspis* are non-randomly distributed across the bedding plane, with half of the 48 individuals of *Groenlandaspis* present on just four of the 200 slabs. The close proximity of the majority of *Groenlandaspis* sp. individuals to one another combined with the overall low abundance of the taxon in the fauna, compared to the other placoderms, suggests their grouping is a product of social behaviour, rather than a taphonomic artefact. This distribution, therefore, possibly represents the earliest example of preserved social behaviour in fishes. Sections of the Canowindra billabong still await to be uncovered, and further excavations of the site may illuminate yet unanswered questions about its fauna, ecology, and taphonomy.

***§ 3D reconstruction of a new species of predatory eubrachythoracid (Placodermi, Arthrodira) from the Late Devonian Gogo Formation, Western Australia**

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Digital technology has forever transformed the way we study and reconstruct prehistoric organisms. The renowned preservation quality of fish fossils from the Late Devonian (364–362 Ma) Gogo Formation, Western Australia, provides an opportunity to investigate the anatomy of this fauna in undistorted three-dimensional space. A new complete specimen of a species in the enigmatic arthrodire genus *Kimberleyichthys* Dennis & Bryan, 1983, is reconstructed using 3D-models derived from CT-scan data. The specimen consists of a nearly complete cranium including the cheek and tooth plates, as well as delicate visceral elements, such as the parasphenoid, autopalatine, nasal capsule, mentomeckelian and ethmoid ossifications. This new species exhibits unique adaptations relating to the functional morphology of the jaw, including an s-shaped suture between the suborbital and post-suborbital bones, and a well-defined suborbital internal ridge. The 3D reconstruction of the jaw and cheek region reveals a relatively large cavity for the mandibular jaw muscles. The *Kimberleyichthys* sp. is a comparatively large arthrodire in this fauna, though still dwarfed by some specimens of *Eastmanosteus*, alluding to a mesopredatory ecological role. Phylogenetic analyses incorporating updated character scorings for the taxon based on this more complete specimen of a *Kimberleyichthys* sp. supports the previously hypothesised position of the genus within the family Plourdosteidae Vezina, 1990 with *Plourdosteus* (Woodward, 1892), from the Miguasha Lagerstätte, Canada, and *Panxiosteus* Wang, 1979, from Yunnan, China

*** Revealing the cranial anatomy of the Triassic temnospondyl *Deltasaurus kimberleyensis* (Stereospondyli, Rhytidosteidae) using synchrotron scanning**

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Deltasaurus is an Australian rhytidosteid temnospondyl from the Early Triassic and includes the species *Deltasaurus kimberleyensis* (type species) and *Deltasaurus pustulatus*, collected from the Blina and Kockatea shales, WA, respectively, in 1965. Both have gone without review since collection, leading to a significant gap in our understanding of the Australian temnospondyl fauna. At the time of publication, *Deltasaurus* was one of only three published rhytidosteids, along with *Peltostega* and *Rhytidosteus*, which were used for comparative purposes. The significance of the morphological variation between the two species only received cursory assessment in the initial publication, with *D. pustulatus* excluded from all phylogenetic studies. The material is of significant interest, due to the increased focus on phylogenetic studies of the rhytidosteid group, which have placed *Deltasaurus* within Derwentiinae, a group nested within Rhytidosteidae. Since their initial description, additional rhytidosteid taxa have been discovered and utilised in phylogenetic revisions, the most recent of which reported poor resolutions outside of Derwentiinae. The *D. kimberleyensis* material is preserved primarily as fragmented natural moulds, and *D. pustulatus* is a singular specimen that only preserves a partial skull table. This has impeded the phylogenetic studies done in the recent past and limits their descriptive potential. The primary specimens used in this study of *D. kimberleyensis* and *D. pustulatus* were scanned at the Australian Synchrotron. This digital fossil preparation reveals novel features hidden in the matrix, including dentition, elements of the skull roof (particularly internal properties), the palatal surface, and new details of the ornamentation. These new data will form the basis of a redescription of the species, an amended diagnosis, and revisions of current character-taxon matrices for phylogenetic analysis, with further implications for the wider Stereospondyli phylogeny.

***§ An embolomerid humerus inside out: Life history traits of a non-amniote tetrapod revealed by synchrotron microtomography**

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Embolomeres are an extinct group of non-amniote tetrapods that lived during the late Palaeozoic. Histological analysis of their bones provides valuable information on growth and life history traits. We examined an L-shaped humerus (RM 20.6707, Redpath Museum, Montreal) from the early Tournaisian of Nova Scotia using synchrotron X-ray phase-contrast microtomography. This approach enabled non-destructive reconstruction of bone microanatomy and histological features, including growth marks, vascularisation and cell distribution. The outer morphology, combined with bone compactness analysis, a secondarily enlarged medullary cavity filled with spongy bone, and a thin cortex, indicates a secondarily aquatic lifestyle. Extensive bone remodelling and the presence of longitudinal vascular canals suggest an active metabolism. Nine lines of arrested growth show that the individual lived for at least nine years, while reduced deposition beyond the fifth growth mark suggests the onset of sexual maturity at around five years. The absence of calcified cartilage and intense remodelling in the metaphysis confirm an advanced ontogenetic stage. Bundles of Sharpey's fibres and locally dense vascularisation highlight strong muscle attachments along the shaft, where stress was recorded in the microstructure. Together, these features suggest that embolomeres adopted growth strategies different from slow-growing Devonian stem tetrapods such as *Acanthostega*, and closer to that of early Carboniferous tetrapods like *Whatcheeria*. This study reconstructs the life history traits of this embolomere and contributes to our understanding of tetrapod growth strategies during the Palaeozoic.

§Digital analysis reveals high morphological disparity in the Devonian lungfish *Chirodipterus australis* (Sarcopterygii: Dipnoi)

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Lungfishes (Dipnoi) first appeared in the Early Devonian and represent one of the most enduring vertebrate lineages, with an evolutionary history of more than 420 million years. Although today they survive as a small survivor lineage, during the Devonian they were diverse and ecologically significant. The Late Devonian (Frasnian) Gogo Formation of Western Australia preserves some of the best lungfish fossils and the most diverse assemblage known, with eleven described species, one of which is *Chirodipterus australis* Miles, 1977. Since its original description, only limited studies have contributed to our knowledge of this taxon. *Chirodipterus* represents a short-snouted form with a robust, powerful mandible, providing a reference for understanding form and ecological strategies in early dipnoans. Here, we present an undescribed specimen of *Chirodipterus* (WAM 90.10.08), deposited in the Western Australian Museum, documented with high-resolution micro-CT to reveal internal cranial, palatal, and dental structures. Comparative analysis of additional specimens from ANU collections, examined with 3D surface scans, provides a framework for assessing intraspecific variation. We identify variation in tooth plate and parasphenoid morphology, both functionally linked to feeding. Preliminary observations also suggest variation in cranial proportions and snout pore arrangement, pending confirmation. These differences suggest distinct morphogroups within *Chirodipterus*, comparable to ecological specialisation in extant reef fishes. This indicates that trophic diversification, characteristic of modern reef ecosystems, had already emerged among lungfishes by the Late Devonian. The dataset provides a framework for scoring cranial characters in phylogenetic analyses and for reassessing the long-standing “Chirodipterid Problem,” namely whether Australian species traditionally assigned to *Chirodipterus* are truly congeneric with those from Europe and North America.

* A new Pleistocene genus and species of pig-footed bandicoot (Marsupialia: Chaeropodidae) from Lindsay Hall Cave, Western Australia

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Chaeropodids (pig-footed bandicoots) are a poorly understood group of peramelemorphian marsupials. Two species, *Chaeropus ecaudatus* and *C. yirratji* survived until the 20th century and have late Pleistocene records. They were unusual among bandicoots for having been grazers rather than omnivores. A third species, *C. baynesi*, is known only by three isolated molars from the early Pleistocene Fisherman’s Cliff Local Fauna in New South Wales. Here, we introduce a new species and genus of chaeropodid based on craniodental material from a presumed early Pleistocene-aged assemblage within Lindsay Hall Cave, Nullarbor Plain, Mirning Country, south-east Western Australia. This taxon presents several likely-neomorphic dental structures—unique among bandicoots and bilbies—including a posterior cingulid and a V-shaped structural complex in the typical entoconid position. It also differs starkly from species of *Chaeropus* in having a markedly short dentary, presumably reflecting a comparatively short rostrum. Preliminary phylogenetic analysis places this taxon within Chaeropodidae. The new taxon increases our understanding of the morphological diversity in this clade of ecologically divergent bandicoots.

*§ The origins of grazing kangaroos and wallabies inferred from molecular data

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The crown radiation of macropodine kangaroos and wallabies is a key component of major faunal turnover in late Cenozoic Australia. The timing and ecological drivers of macropodine diversification have often been related to forest fragmentation and open habitat expansion following the Middle Miocene Climatic Optimum (MMCO, ~14–13 Ma) but remain debated. Here, we present phylogenetic analyses of complete mitochondrial genomes and 11 nuclear loci, calibrated with 17 node-based fossil calibrations, to reassess divergence times, lineage diversification, and the origins of grazing in this clade. We infer that the macropodine stem lineage originated during the early to middle Miocene (14–18 Ma), but crown macropodines originated substantially later, ~8–9 Ma. The earliest divergences, including Dorcopsini, Dendrolagini, and Macropodini, occurred within a narrow ~1.5-million-years window, in association with increasing late Miocene aridity rather than earlier post-MMCO forest opening. Lineage-through-time analyses reveal a significant diversification spike in the early Pliocene (~5–4.3 Ma), including the basal radiation of the “*Macropus*” clade (*Macropus*, *Notamacropus*, *Opshranter* and *Wallabia*) and crown origins of several other macropodine genera. Ancestral diet reconstructions favour multiple late Miocene transitions from browsing to mixed feeding, with grazing first emerging along the lineage leading to “*Macropus*”. These phylogenetic signals for grazing precede peak grassland expansion (~3.6 Ma), aligning instead with earlier evidence of increasing graminoid pollen. We propose that once grasses (and potentially other phytolith containing graminoids) became sufficiently abundant to provide a fitness advantage, grazing kangaroos and wallabies rapidly radiated. Together, our molecular timetree and trait reconstructions demonstrate that macropodine diversification was “delayed” until after the MMCO and accelerated in response to aridification and then incipient grassland expansion.

*§ Investigating the position of *Dsungaripterus weii* on the pterodactyloid phylogenetic tree

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Dsungaripterus weii is an aberrant pterodactyloid from the Cretaceous Junggar Basin of China. Due to its unusual anatomical characteristics, various phylogenetic relationships have been suggested for it based on different analyses. In this study, *D. weii* was added to a new character and taxon matrix, based upon data gathered from previous phylogenetic analyses and anatomical descriptions of nine other pterosaurs representing major clades and including 99 characters, to determine which non-dsungaripterid pterodactyloid taxon or clade it was most likely the sister taxon or outgroup to. The analysis recovered *D. weii* as a member of the clade Tapejaroidea and a sister taxon to members of the clade Azhdarchoidea, proving this to be the most reliable hypothesis. Analysis of characters showed that *D. weii* shared many derived characteristics of the postcranial skeleton with azhdarchoids, but its skull was more typical of a basal ornithocheiroid, potentially providing an example of modular evolution. Other interesting results include the recovery of the clade Dsungaripteroidea as not being synonymous with Lophocratia, indicating that Archaeopterodactyloidea might be paraphyletic and includes the majority of pterodactyloids, and the recovery of a clade between *Quetzalcoatlus lawsoni* and *Tupuxuara leonardii* excluding *Tapejara wellnhoferi*, potentially indicating that Tapejaridae is also paraphyletic. Eight novel synapomorphies were also tentatively identified across Pterodactyloidea, which may be helpful in classifying pterodactyloids known from fragmentary remains. However, bootstrap p-values indicate that while Tapejaroidea is a well-supported clade, Azhdarchoidea is less so, meaning it is possible *D. weii* was actually within Azhdarchoidea. Additionally, the Dsungaripteroidea and *Q. lawsoni* + *T. leonardii* clades were poorly supported by the bootstrap analysis. Future analyses will include more pterosaurs, with the aim of minimising the impact of errors and further investigating whether these groupings are likely.

* Molecular palaeontology of *Diprotodon* fossils from Lake Callabonna

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Molecular palaeontological interests have intensified in recent years with a greater appreciation for the preservation of ancient biomolecules in certain depositional environments or mineralisation processes. Here, we report the molecular biomarker appraisal of a well-preserved 48-ka *Diprotodon* fossil excavated at Lake Callabonna (northeast region, South Australia), with a particular focus on the very early diagenetic steroid transformation reactions. The giant wombat-like *Diprotodon optatum*, was the world's largest-ever marsupial and an iconic member of the herbivore guild in Pleistocene Australia. The steroid biomarker composition of 1) bones, 2) gut cavity sediment, and 3) fur marked concretions were analysed by GC-MS of saturate, aromatic and polar (BSTFA derivatised) fractions. Functionalised sterol biolipids and a limited suite of diagenetic derivatives (e.g., sterenones, sterenes and steradienes) were detected, but no fully saturated or aromatic steroids, reflective of the immature nature of the organic matter. In particular, the detection of just (derivatised) cholesterol and cholest-2-ene from bones is indicative of the very first step of diagenetic transformation, which to our knowledge has not previously been seen exclusive of further diagenetic progression in any other fossilised or sedimentary OM. The $\delta^{13}\text{C}$ values of gut-derived C27 sterenes (-15.1 ‰ VPDB) and plant-derived C29 sterenes (-22.9 ‰) and high-molecular-weight n-alkanes (-21 to -25 ‰) were measured by compound specific isotope analysis (CSIA). These $\delta^{13}\text{C}$ values (> -25 ‰) are consistent with C4 plant sources, varieties of which (e.g., chenopods, euphorbias, saltbush) were prominent within the environs of the dry salt-lake of Lake Callabonna. The $+7$ ‰ enrichment of the C27 sterene (Cf. C29) is consistent with the higher trophic level of diprotodont gut steroids. Similar molecular and isotopic analyses of *Genyornis* fossils also discovered at Lake Callabonna are presently underway to investigate the palaeo geobiology of these extinct birds.

Steroids in fossil vertebrates: Early diagenetic processes

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The preservation of endogenous biomolecules within fossilised vertebrate tissues offers rare but transformative insights into ancient physiology, ecology, and fossilisation processes. Here, we integrate organic geochemical and mineralogical evidence from four exceptionally preserved vertebrate systems spanning more than 100 million years of vertebrate evolution: late Pleistocene *Diprotodon optatum* and *Genyornis newtoni* from Lake Callabonna (South Australia), a Cretaceous pterosaur from Brazil, and a Miocene cetacean from Oregon (US).

GC-MS analyses of *Diprotodon* bone, gut-cavity sediment, and fur-marked concretions reveal functionalised sterols and limited diagenetic derivatives (e.g., sterenones, sterenes, steradienes), but no fully saturated or aromatic steroids, capturing the earliest stage of steroid diagenesis. Compound-specific isotope analysis (CSIA) of C27 and C29 sterenes (-15.1 to -22.9 ‰ VPDB) indicates dietary dependence on C4 vegetation such as chenopods and saltbush within an arid salt-lake ecosystem. *Genyornis* fossils from the same locality show similar molecular and isotopic signatures. In contrast, the Cretaceous pterosaur in a concretion preserves steroid biomarkers within a phosphatic-carbonate matrix formed through multi-staged mineralisation. Localised acidic-oxidative microenvironments promoted fluorapatite and carbonate precipitation, encapsulating compounds. The $\delta^{13}\text{C}$ values of cholesterol (-19 ‰) and ethylcholesterol (-29 ‰) are consistent with a marine diet of fish/cephalopods. Hydropyrolysis of kerogen liberated low-molecular-weight alkanes and steranes dominated by C27 cholestanes, indicating limited terrestrial

influence.

Complementary analyses of a Miocene cetacean humerus reveal molecular and isotopic evidence of fossilised bone marrow microenvironments. Trabecular bone extracts are dominated by early diagenetic cholesteroids, distinct from the marine sterane-rich carbonate concretion that encapsulated them. Collectively, these findings demonstrate that diverse early diagenetic and mineralization pathways—from arid immobilisation to oxidative phosphatisation and microenvironmental carbonate sealing—can preserve endogenous steroids and other biomolecules over geological timescales. This multi-system comparison refines understanding of fossilisation chemistry and highlights the deep-time persistence of vertebrate molecular biosignatures across both terrestrial and marine settings.

§Scratches and pits on the road to understanding the evolution of mega-marsupial diets using dental microwear

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Dental Microwear Texture Analysis quantifies microscopic marks left on enamel surfaces by food and ingested grit. It can be used to compare microwear patterns of modern species that have known diets with those of fossil species to infer their diets. One challenge, as with many biological systems, is that these datasets are inherently noisy and can be difficult to correlate with the variable diets of wild animals. Our approach uniquely addresses this challenge by combining relatively high sample sizes with mixed modelling techniques that allow for multiple intra-specimen sampling. Here we report on dental microwear signatures of >20 extinct vombatiform marsupial species, primarily diprotodontids and palorchestids, and compare the patterns observed with those of kangaroos using linear mixed models. Our deep time generalised additive mixed models show a general trend toward consuming tougher browse vegetation occurred in the Late Miocene, prior to a shift to more grazing in the Pliocene, before dietary diversity and variability increased in the Pleistocene. Palorchestids appear to have remained primarily browsers throughout their history. We also consider the potential influences on microwear patterns of taphonomy, fossil specimen selection, tooth size and inter-observer variation, which only become apparent with high sample sizes, and discuss statistical methods to ameliorate their confounding impact on signal. This approach holds promise for future application to any mammal group for which large samples exist, including primates and ungulates.

* New burrowing bat fossils (Chiroptera: Noctilionoidea: Mystacinidae) signal significant biodiversity loss since the Miocene in New Zealand

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The family Mystacinidae, which is part of the only Gondwanan bat superfamily Noctilionoidea, is restricted to New Zealand today but once also occurred in Australia. Also known as burrowing or short-tailed bats, mystacinids are semi-terrestrial, omnivorous chiropterans that are ecologically important and morphologically very distinctive, with many specialised craniodental and skeletal traits making their fossils generally clearly identifiable. The only two modern mystacinid species, the vulnerable *Mystacina tuberculata* and critically endangered or extinct *M. robusta*, are known from numerous Pleistocene and Holocene cave deposits in New Zealand, but the fossil record also shows that mystacinids were present in New Zealand from at least the Early Miocene 19–16 million years ago, and in Australia during the Oligocene and Miocene 26–12 million years ago. New bat fossils recovered from Lower Miocene lacustrine sediments near St Bathans in Central Otago, in the rohe of Ngāi Tahu Whānui, Te Waipounamu, Aotearoa (South Island, New Zealand) represent several mystacinid taxa, including a diminutive new species. This brings the number of St Bathans Early Miocene mystacinid species now known to five. Global climate change following the Middle Miocene Climate Transition (MMCT 14.2–13.8 million years

ago) brought colder and drier conditions, resulting in significant changes in vegetation and palaeoenvironments in New Zealand. It is likely that this triggered overall reduction in bat diversity in New Zealand, including loss of the largest (estimated 41 g body mass) and smallest (~8–10 g) known mystacinid bats, and probably the corresponding ecotypes. Overall, Holocene bat diversity appears to be less than half it was in Early Miocene New Zealand.

Temnospondyl body mass — why do we care?

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Temnospondyl amphibians provide a rare test case: a diverse, globally distributed vertebrate group that endured for ~210 million years and repeatedly crossed mass-extinction boundaries. Despite this unusual longevity and ecological breadth, a clade-wide, timescale-aware picture of body-size change has been lacking. Because body mass underpins metabolism, trophic role, and life history, reconstructing its trajectory offers a direct window onto ecosystem structure and survivorship across crises. The aim here is to quantify how temnospondyl body mass varied through time and across clades, and to present the first en masse, chronostratigraphically aligned, synthesis for the group. A specimen-level dataset spanning ~309–184 Ma was compiled, representing 14 clades and six geographic regions (predominantly Australia and North America, with additional records from Europe, South Africa, Antarctica and India). Masses were estimated using recently established approaches applicable to both complete and fragmentary material, and occurrences were placed on a common geological timescale to enable direct comparison through time. The aggregate pattern is non-monotone, with intervals of relative stability punctuated by abrupt shifts that coincide with major environmental transitions. Clades follow distinct temporal trajectories rather than a single directional trend, indicating repeated restructuring of size distributions rather than passive drift. Taken together, these results show that temnospondyl body size was highly dynamic across deep time. In a wider evolutionary context, the findings clarify how vertebrates respond to catastrophic environmental upheavals, providing a clear baseline for inferring resilience and recovery.

A new archaeolamnid shark from the ‘middle’ Cretaceous of Queensland with insights into Archaeolamnidae (Neoselachii: Lamniformes) systematics

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Lamniform sharks peaked in taxonomic richness during the Late Cretaceous. However, comparably less is known about their Early Cretaceous diversity. To this end, the Aptian–Albian marine deposits of the Eromanga Basin have significant potential to reveal Early Cretaceous lamniform diversity in Gondwana. Here, we investigate collections of shark teeth from the shallow marine upper Albian Mackunda Formation, revealing an abundant *Archaeolamna*-like taxon possessing a labiolingually thin root with an apically directed, apicobasally-pinched lingual protuberance variably bearing a nutritive groove. These features are uncharacteristic of *Archaeolamna* sensu stricto and likely represents a new genus and species. This novel taxon shares the following characteristics with Archaeolamnidae: weak root heterodonty, a thin lingual neck that does not expand towards the centre of the crown, and gracile commissural teeth bearing strong, basally originating folds on the labial crown face. Referrable teeth are also documented from the overlying Winton Formation and the coeval Griman Creek Formation within the adjacent Surat Basin to the southeast. The tooth morphology across the dentition of this new taxon shows tearing-type anterior crowns, similar to those of *Archaeolamna kopingensis* from the Campanian of Sweden, while the lateroposterior crowns are more cutting-type as in the purported North American subspecies *Archaeolamna kopingensis judithensis*. Qualitative and quantitative comparisons of dental variation between these two Campanian taxa support the elevation of the North American taxon to *Archaeolamna judithensis*. The locality within the Mackunda Formation where this new archaeolamnid occurs favours the preservation of smaller juvenile teeth, and the locality is further enriched in pristine, tiny orectolobiform

teeth. Therefore, a comprehensive description and establishment of this new archaeolamid genus and species awaits the discovery of larger adult teeth, perhaps from other Mackunda Formation localities that better preserve larger specimens.

§ Long gone wobbegongs: A new species of orectolobiform shark from the ‘middle’ Cretaceous of Australia

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Orectolobiforms are an order of neoselachian sharks first recorded in Jurassic deposits of Europe. While they reached a global distribution during the Cretaceous, their fossil record is strongly biased towards the Northern Hemisphere, particularly North America and Europe. Currently, <1% of Cretaceous orectolobiform occurrences in the Palaeobiology Database (4 out of 491) are from the Southern Hemisphere. During the middle Cretaceous (110–100 Ma), much of eastern Australia was inundated by the shallow epicontinental Eromanga Seaway, preserved through a succession of marine sediments in the Rolling Downs Group. Taxonomic descriptions and interpretations reveal an abundance of well-preserved shark teeth within the Rolling Downs Group, including multiple species of orectolobiforms. Here, we report on a new orectolobiform shark that occurs across the Albian-aged sediments of the Rolling Downs Group of Queensland. This species is distinguished by the following morphological characteristics: large anterior teeth (>10 mm in adult specimens), a lingually recurved main cusp with strong lingual folds, and an apicobasally short labial apron embedded in the labial root face of adult individuals. Sampling across the Rolling Downs Group suggests the new orectolobiform species commonly occurred in nearshore to marginal marine palaeoenvironments. Additional occurrences are noted in contemporaneous but more offshore deposits from the marine Gearle Siltstone in Western Australia, which are also restricted to the Albian. Phylogenetic analyses indicate this new species, along with other Cretaceous orectolobiforms, are stem orectolobids, the family that includes extant wobbegongs, supporting a later Cenozoic origin for the crown group. However, the inclusion of fossil taxa known only from isolated teeth remains controversial and further work is needed to better incorporate tooth-based characters into phylogenetic matrices. The discovery of a new Australian endemic orectolobiform species highlights the role eastern Australia will play in revealing the diversity of sharks from the Southern Hemisphere.

New findings on the cranial anatomy, neuroanatomy and palaeobiology of *Muttaborrasaurus langdoni* Bartholomai & Molnar, 1981, a large-bodied ornithopod from the mid-Cretaceous of Australia

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The large-bodied ornithopod *Muttaborrasaurus langdoni* is Queensland’s fossil emblem and an iconic Australian dinosaur. Discovered near Muttaborra in 1963, the holotype (QMF6140) was described and named in 1981 and further descriptive work followed in 1996. Following these publications, no additional anatomical work was undertaken on the holotype and the holotype locality has not been reworked. A distinctive feature of the skull is its pronounced nasal bulla, thought to be formed by the nasal bones, but its function remained uncertain. The front of the muzzle, although missing, was assumed to be toothless and bill-like, like *Iguanodon*. The original descriptions of the skull were superficial and undertaken without the benefit of advanced imaging techniques. In 2020, our team rediscovered the holotype locality, which had become lost. From the excavations that followed, additional jaw fragments were found, including fragments of the premaxilla. Using CT scans and volume rendered models, we extensively revise the skull. Surprisingly, the premaxillary beak has well-developed teeth, unlike iguanodontians but akin to early diverging ornithischians. The nasal bulla is not formed from the nasals, but potentially from complex neomorphic bones or the premaxilla, and is interpreted as the olfactory meatus. Enlarged

olfactory bulbs further suggest a highly developed sense of smell. Binocular vision was limited but lateral monocular vision was broad. Proportionately large anterior semicircular canals and relative mass of the cerebrum are consistent with bipedal locomotion. The discovery of three *Muttaborrasaurus* individuals in shallow marine strata of the Eromanga Sea, suggests a genus that inhabited the coastal plain, possibly near the shoreline, tidal flats, distal rivers, brackish estuaries or salt marshes. Furthermore, the possible development of salt glands housed in lateral fossa in the main airway, consistent with the location of nasal salt glands in other reptiles, suggests *Muttaborrasaurus* collaterally ingested excess salt with food.

***§ Character vs morphometric data: Evaluating uncertainty in frog fossil identification amid missing data**

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Morphological analyses are often complicated by the fragmentary nature of fossils, yet few studies have explicitly tested how commonly used analytical methods perform under degraded conditions. Two widely used approaches—character coding and shape analysis (geometric morphometrics)—both aim to differentiate species based on form but do so in fundamentally different ways. This project evaluates their resilience to missing data using 12 species of native South Australian frogs from three families (Limnodynastidae, Myobatrachidae, and Pelodyadidae) as a case study. Ethanol-preserved specimens ($n = 94$) were scanned with micro-Computed Tomography to generate 3D surfaces of the ilium, sacral vertebra, humerus, and scapula for landmarking. Landmark-based shape data were analysed via Procrustes superimposition, where non-shape variation—size, orientation, position—is removed. Meanwhile, the morphological characteristics of these specimens were scored in a character matrix drawn from published studies and augmented with new observations, including both binary and multistate characters. The morphometric and character data were analysed in the R statistical environment where pairwise distances between specimens were calculated using Procrustes and Gower’s distances, respectively, and visualised using Principal Coordinates Analysis (PCoA). To simulate taphonomic damage, both datasets were systematically degraded and reanalysed to test the stability of taxonomic grouping. Preliminary analyses suggest differences in the tolerance of the two methods to missing data, with geometric morphometrics potentially offering greater resilience. By directly testing analytical methods under simulated fossil conditions, this study demonstrates how each approach responds to missing data and offers practical guidance for palaeontological identification.

Found a Fossil? Enhancing public awareness and protection of Australia’s vertebrate fossil heritage beyond museums

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Australia’s vertebrate fossil record has been significantly shaped by non-scientists, with nearly 70% of known dinosaur species and specimens discovered by farmers, miners, and other members of the public. While dinosaurs are just one fossil group, countless other vertebrate fossils—ranging from ancient marsupials to marine reptiles—would likely have remained undiscovered without the involvement of the public, their movement across the land, and their curiosity in what lies beneath it. Despite this, public understanding of fossil significance and reporting protocols remains limited, and many potential finds may be lost to science due to misidentification or uncertainty about who to contact. While museums are well-positioned to communicate fossil-related information to the public, they often face limitations in extending protection to specimens or sites beyond their walls. The *Found a Fossil Project* addresses this gap by investigating public attitudes toward fossil finds and serving as a platform to promote accessible resources, improve fossil visual literacy, and foster awareness of their scientific and cultural significance. Through this and several other grassroots initiatives, we highlight sustainable collaborations between palaeontologists, farmers, Indigenous communities, and the broader public—demonstrating how shared

stewardship and inclusive engagement can enhance fossil protection across diverse landscapes. Case studies such as the Broome dinosaur trackways and the *Rola[Stone]* documentary illustrate how community-led discoveries, cross-cultural partnerships, and media storytelling can amplify fossil awareness and support ethical heritage care in remote and regional contexts.

§ Devils in the west: Comparative shape analysis of fossil and modern *Sarcophilus harrisii* skulls

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Cranial diversity in mammals often reflects ecological adaptations, with intraspecific variation arising over time from environmental changes, climatic factors, and geological isolation. The Tasmanian devil (*Sarcophilus harrisii*) is the largest living carnivorous marsupial and plays an important scavenging role within the ecosystem. Currently restricted to Tasmania, the devil was once widespread across the Australian continent and estimated to have gone extinct from the mainland during the late Holocene. Fossil devils dated to the Late Pleistocene/Holocene have been found in caves within southwest Western Australia (WA). During the Plio-Pleistocene, the continent underwent major transformations in climate, vegetation and hydrology. This resulted in many populations of species becoming fragmented, forcing them to survive in pockets of suitable habitat until they were driven to either local extinction or adaptation. The southwest is believed to be an example of this process. We here ask whether isolation and ecological distinctness are reflected in morphological differences between the southwestern Australian devil population and extant devils from Tasmania, as well as Pleistocene fossils from across the continent. For this, we use 3D geometric morphometric analysis of 160 surface-scanned crania to investigate variation in cranial shape between extinct and extant Tasmanian devils across Australia (including 15 fossils from WA). Preliminary results suggest strong allometry, but also substantial differences in skull shape between fossil and extant specimens, with the WA subset potentially showing skull morphology consistent with adaptation to different ecology, environment or climate.

***§ Rediscovering Zealandia's Dinosaurs: A review of the Mesozoic terrestrial vertebrate fauna of New Zealand**

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The microcontinent Zealandia preserves a sparse record of terrestrial vertebrate material from the Mesozoic, mainly represented by fragmentary bones from Jurassic and Cretaceous deposits in the North Island assigned to Dinosauria. Since the early 2000s, New Zealand has experienced a notable hiatus in the collection or description of new material from both historic and potential fossil localities. Since the last descriptions over a decade ago, new Gondwanan discoveries have provided additional comparative material, leaving Zealandia's Mesozoic terrestrial record comparatively understudied. This review aims to reassess the taxonomic and biogeographic significance of the existing New Zealand fossil material in the context of current Gondwanan records. It also considers the potential of applying modern analytical techniques to these specimens, such as quantitative morphometric analyses and use of high-resolution digital scanning, which are transforming how fossil data can be studied. Incorporating these approaches may yield new insights that enhance our understanding of this Mesozoic fauna and its broader evolutionary significance. In addition to the application of modern analytical approaches, other potential future research priorities are discussed, including renewed field investigations at historic localities and exploration of under-sampled formations of relevant geological age. Also explored is the broader consideration of why the New Zealand record has received comparatively little attention in recent decades, despite it being a crucial component of unravelling Gondwanan vertebrate evolution alongside more extensively studied regions. Although fragmentary, Zealandia's terrestrial vertebrate fossils provide critical evidence and insights into reptile diversity and biogeography at southern high latitudes in the

middle to late Mesozoic. A comprehensive synthesis of the current record is necessary to underscore the broader importance of Zealandia's Mesozoic terrestrial vertebrates moving forward.

Insights into the life history of the giant fossil kangaroo *Protemnodon viator* from an articulated mother with pouch joey

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Little is known about the ecology of Australia's extinct marsupial megafauna. One such species, *Protemnodon viator*, was a giant kangaroo that inhabited Pleistocene ecosystems across central Australia and has been conflictingly characterised as a fairly able bipedal hopper or predominantly quadrupedal. Here we report on nine specimens of *P. viator* from Lake Callabonna, northeastern South Australia, focussing on exceptional new articulated skeletons of a mother and joey. These shed light on the life history of the species and allow us to consider why it may have been susceptible to extinction. Comparative skeletal description, limb measurements, and molar eruption and progression data align the joey's development with that of living macropodin pouch young aged 6–9 months. Bone histology revealed extremely rapid growth in the joey's femur but not humerus, representing the first detection of 'catch-up' growth following ossification heterochrony in a fossil marsupial. Maximised hindlimb growth and similarly short forelimbs to living macropodin joeys suggests *P. viator* had a similar requirement of pouch young to rapidly develop a fast bipedal hop, possibly to evade predation during this vulnerable life stage. Body mass estimates using established methods and datasets found sexual size dimorphism was less in the *P. viator* sample than predicted by trends in living macropodins. Masses did not reach the hypothesised 160-kg limit for bipedal hopping, above which gastrocnemial tendon rupture is predicted. We suggest that *P. viator* was limited in the maximum body mass of its large males by its need to hop. These findings have implications for why *P. viator* may have become extinct.

§Do migratory parrots pack light for their domestic flights?

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Migratory movement patterns have evolved multiple times in the avian tree, yet most evidence for brain-behaviour links between migratory and non-migratory species comes from studies of songbirds. In songbirds, migration is associated with relatively smaller brains and cerebral hemispheres, traits linked to the energetic costs of migration and reduced behavioural flexibility. Without broadening this perspective to other lineages, it remains uncertain whether such associations can be reliably applied to birds that may have adapted differently, including extinct taxa. Among parrots, the sister group to songbirds, species are typically classified into four movement categories: sedentary, nomadic, partial migrant, and full migrant. Here, we test whether parrots exhibit similar brain adaptations using μ CT-scanned skulls to generate digital endocasts. Apart from the migrant species having a larger cerebellum at larger sizes, movement pattern was not associated with differences in relative brain or brain region size. While we cannot rule out neuroanatomical variation not detectable in endocasts, our findings suggest that migratory parrots do not have substantially different brain structure compared to other parrots, unlike the pattern observed in songbirds. This may imply that endocast morphology alone may be insufficient for inferring migratory behaviour in non-songbird fossils, at least not in cases like our parrot sample where migration distances are relatively short.

Revised osteology of *Australovenator wintonensis* Hocknull et al., 2009, Australia's most complete non-avian theropod dinosaur

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Australovenator wintonensis (Theropoda: Megaraptoridae) from the lower Upper Cretaceous (Cenomanian–?Turonian) Winton Formation of Queensland is the most complete non-avian theropod ever described from Australia. The holotype and only known specimen is represented by a partial mandible, dorsal ribs, gastralia, forelimb and hind limb elements, and is one of two Australian taxa pertaining to the Megaraptoridae (*Rapator ornitholestoides* being the other). Megaraptorids are known only from the Cretaceous of Australia and South America and are characterised by highly-developed axial pneumaticity, as well as enlarged forelimbs with trenchant claws. Within Megaraptoridae, *Australovenator* is the only taxon that preserves the dentary and hind limb, and one of two taxa preserving a near-complete forelimb. Consequently, *Australovenator* is a keystone specimen for identification and interpretation of megaraptorid remains. Herein, we provide a detailed redescription of the holotype specimen of *Australovenator wintonensis*. We provide revised interpretations of several axial, forelimb and hind limb elements, and use Synchrotron-CT data to identify the supradentary and the interdental plates. Utilising a well-established matrix for the investigation of megaraptorid interrelationships, we perform a parsimony-based phylogenetic analysis. We make several modifications to the character states of *Australovenator* and further undertake a comprehensive review of character states for the remaining 57 taxa in this analysis. Following these results, we review the synapomorphies of Megaraptoridae and highlight the importance of *Australovenator* for the understanding of this group. Previously, the descriptions of *Australovenator* were spread across several individual publications, and a dedicated phylogenetic analysis had not been performed since the taxon was first described, perpetuating ongoing issues with comparisons of material and phylogenetic character scores. By collating all known material into a single manuscript and updating matrices to reflect the most accurate interpretation, we lay a key foundation for taxonomic comparisons and analysis of future megaraptorid remains.

***§ Why do kangaroos hop? Biologically informed ancestral trait reconstruction for tracing the evolution of foraging and locomotion among macropodids**

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There is a close relationship between the locomotion of animals and their occupation of foraging ecospace. Mammals display a wide range of locomotory modes, among which bipedal hopping is thought to have evolved independently multiple times within both marsupials and placentals. However, marsupial kangaroos, wallabies, bettongs and potoroos (Macropodoidea, Diprotodontia), and placental springhares (*Pedetes*, Rodentia), are the only extant hopping mammals above 500 g. In this study, we consider how evolutionary contingencies associated with foraging and locomotion might have driven these phylogenetically distant taxa to converge on a similar hopping gait mode; essentially asking why do kangaroos hop? Here, phylogenetic ancestral trait reconstructions of Australasian macropodids and African springhares were performed to trace the evolution of foraging height and locomotion. The results highlight that the ancestry of medium to large-bodied (≥ 500 g) hopping macropodids was likely subject to selection pressures for efficient terrestrial locomotion at faster gaits, as well as digging and evolutionary contingency associated with climbing ancestry; these conditions that could have caused evolutionary conflicts, especially at larger size. Evolving bipedal hopping could have resolved such functional conflicts by uncoupling hindlimb specialisation (terrestrial locomotion) from forelimb specialisation (digging/climbing). Bio-mechanical constraints and anatomic characteristics (i.e., functional morphology) facilitating the evolution of macropodid hopping will need to be further considered as part of future studies, including using geometric morphometrics.

§Re-evaluation of birds in the Australian Quaternary fossil record reveals greater diversity than previously recognised

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The Australian bird fauna is one of the most unique in the world, with ~900 extant species, but understanding of the processes that shaped today's avifauna remains incomplete. Due to their unique ecological attributes and great diversity, birds stand as important environmental indicators, yet fossil birds have been historically understudied compared to coeval mammal faunas. We undertook a systematic review of published occurrences of Australian fossil birds in the Quaternary to better understand the current state of the field, and outline areas for further consideration. A total of 179 publications, spanning 159 years (1866–2025), provided novel data on the occurrence of Quaternary bird fossils in Australia. These reported on over 300 distinct Quaternary aged fossiliferous sites, with a mean species richness of 3.5 birds per site, but a median richness of 1. Sixty-six avian families are currently represented in the Australian Quaternary fossil record, but the true diversity of fossil birds is likely much greater. Detailed examination of individual taxon occurrences indicated that less than half of such reports were conducive to independent validation, with 44% listing catalogue numbers for voucher specimens, 34% providing taxonomic justification, and 11% illustrating relevant specimens. Understanding of the history of the Australian avifauna will be greatly enhanced by detailed taxonomic identifications and justification, which will better inform the palaeoecology and biogeography of fossil birds. This is exemplified by ongoing work on the fossil avifauna from Victoria Fossil Cave, South Australia. Previous research on fossil birds therefrom emphasised extinct taxa (of which three have been identified), with only cursory mention of extant taxa. By applying accepted norms to improve repeatability of taxonomic conclusions (reporting voucher specimens, diagnostic traits, comparisons undertaken, etc.), we have already identified ~40 distinct avian taxa from the locality, representing one of the most diverse fossil avifaunas in Australia.

Gogo Formation paleoecology: Fauna and trophic relationships on an ancient Late Devonian stromatoporoid reef

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The Late Devonian (Early Frasnian) Gogo Formation of Western Australia has so far yielded a highly diverse and extremely well-preserved fauna of fishes (>50 taxa), crustaceans such as phyllocarids and concavicularids (>10 taxa), as well as ostracods, conodonts (c. 15 taxa), and several other kinds of invertebrates including nautiloids, goniatites, tentaculitids, conulariids etc. Research has been so far scant on reconstructing trophic levels and the food webs of these reef systems. Our multidisciplinary study is filling this gap by examining specimens to identify trophic interactions through gut remains (computed tomography, neutron beam imaging), coupled with inferences on trophic relationship based on morphological traits and their abundance and distribution between the reef and reef-slope faunal communities. Existing data include those from stomach contents as evidence of direct trophic relationships (e.g., ostracods, fish and arthropod remains inside placoderms). New finite element analyses reveal feeding biomechanics of some of the common species of Gogo lungfishes, with work in progress on arthrodire jaw mechanics and bite forces. Detailed trait analyses provide insight into the diversity and functional characteristics of this ancient ecological community, allowing for comparisons with modern fish communities. The current ARC funded project aims to complete long-standing taxonomic descriptions of several fish taxa, based on new specimens and computed tomography scans of existing specimens. These include the Gogo *Bothriolepis*, revision of major taxa of several arthrodire (e.g., *Torosteus*, *Eastmanosteus*, *Bullerichthys*), revision of problematic dipnoan taxa (e.g., *Chirodipterus*, *Griphognathus*) and descriptions of new forms, including a new stem-chondrichthyan and a new basal sarcopterygian close to the actinistian-onychodontid divergence. Together, these combined studies will allow us to reconstruct

the complexity and stability of the ancient reef ecosystem, and in particular reveal temporal trends in reef trophic complexity over time.

New sites, chronology, and palaeoecological insights from the flooded cave deposits of Mt Gambier

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The flooded deposits of Mt Gambier and its surrounding regions have provided key but relatively poorly understood records of Australian Pleistocene faunas. Here, we report the results of an integrated research project aimed at developing a deeper understanding of the palaeontology and environments preserved in the underwater deposits of southeastern Australia. Physical surveys of several flooded cave systems and sinkholes as well as examination of the grey literature have revealed at least five previously undocumented or poorly documented fossil deposits preserving fossil mammals, with estimated ages ranging from ca. 250,000 to perhaps 500 years. Palaeoecological analyses indicate the presence of temperate woodlands much like those found in the region today. The flooded caves show marked differences from the well-known underwater systems of Mexico, particularly in relation to the extent of cave decorations and archaeological signatures found in the latter. Nevertheless, some similar themes emerge regarding the formation and excavation of deposits in near-shore underwater karstic systems.

Ancient DNA and phylogeography of the world's largest eagle, the extinct Haast's eagle (*Hieraaetus moorei*) of Aotearoa New Zealand

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The extinct pouākai Haast's eagle (*Hieraaetus moorei*) of Aotearoa New Zealand is the largest known true eagle, with a wingspan of up to 2.6 m and weight estimates of 10–16 kg. Despite its enormous size, its closest relative is the little eagle (*Hieraaetus morphnoides*), an Australian species weighing less than 1 kg. Molecular evidence dates the split between these two lineages to approximately 2.2 Ma, implying exceptionally rapid evolution of giant body size in Haast's eagles, likely a response to Pleistocene environmental conditions in an island ecosystem. Pleistocene glacial-interglacial cycles strongly influenced the demography of many New Zealand birds, causing bottlenecks, isolation, and expansion events, including in the medium- to large-bodied prey species hunted by Haast's eagles. However, the impacts of these cycles on New Zealand's apex accipitrid are not yet known. We asked whether Haast's eagles tracked their prey into isolated refugia or remained broadly distributed across the South Island during the Pleistocene. We generated mitochondrial genomes (mtDNA) from 12 Haast's eagle subfossils (aged ~20–1 kya) to examine their phylogeography and test for signals of population contraction or expansion. We observed high haplotypic diversity and a young coalescence of lineages, suggesting strong action of genetic drift. We found very low levels of nucleotide diversity and no evidence for phylogeographic structure or signs of population fluctuation. We infer that Haast's eagles were present in low population densities but were not isolated into refugia by environmental conditions, unlike many other South Island taxa. Our findings suggest Haast's eagles were adaptable predators with broad habitat tolerance. Alternatively, the panmictic patterns we observe in the mitochondrial data may reflect female natal dispersal, a trait observed in many raptors. We outline future genomic approaches to distinguish between these scenarios and deepen our understanding of this apex predator's ecology.

The original mammal fauna of the Nullarbor Plain was decimated when Europeans colonised Australia

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We investigate 17 putatively Holocene fossil assemblages from across the Nullarbor, southern Australia, to identify trends in the pre-European fauna and document the enormous loss of diversity, likely driven by the introduction of exotic herbivores (primarily cattle, sheep, and rabbits) and direct predation of native mammals by introduced carnivores (cats and foxes) following European colonisation of the region. Prior to the arrival of Europeans, the Nullarbor Plain supported at least 46 native mammals (32 species were recovered from a single assemblage). Most of these species have been driven to extinction leaving the Nullarbor's modern mammal assemblage dominated by *Mus musculus*. We use principal component analysis and cluster analyses to investigate geographic relationships in species biogeography. We find that while many species occurred across the entire Nullarbor, seed dependent species with a boom–bust breeding strategy appear to be more common in the western Nullarbor, whereas species that do not boom following rain appear to be more common in the eastern Nullarbor. The more or less uninterrupted distribution of several species across the entire Nullarbor suggests that aridity may not have always been the impenetrable barrier it appears to be today.

It's the little things: An exceptional case of vestibular apparatus shape and relative size in Australia's avian giants, the Dromornithidae (Aves)

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Recent studies have investigated the external and some aspects of the internal cranial morphology of the giant, flightless Dromornithidae (Anseriformes, Aves) from Cenozoic Australia. These structures and their implications for ecological adaptation in this extinct family are now well understood. However, the key sensory system of the paired vestibular membranous labyrinth remains understudied despite its potential to provide insight into macroevolutionary trends across vertebrates. The long temporal range of dromornithids, hybrid cranial morphology, gigantic sizes, a long history of flight loss, and robust leg elements, make dromornithids an interesting case study regarding their vestibular labyrinth morphology. Several species of dromornithids have the osseous casing for this structure preserved in fossil crania, which conserves the shape of the membranous organ. Using landmarking methods, we quantified the shape and relative size of the osseous labyrinth—including its three semicircular canals—to statistically compare it across dromornithid species and other avian groups (Galloanserae, non-galloanseran giant, flightless taxa, and some neoavians). This enabled specific ecological, morphological, and phylogenetic factors to be tested as potential drivers of variation. The dromornithids displayed minimal interspecific variation, notably however, they were unique in both labyrinth shape (particularly proportional sizes of the three canals) and size (far smaller relative to head size) among crown birds, even compared to other giant, flightless taxa. This divergence from the general evolutionary trends previously identified for neornithines, appears to be linked to flight loss and the dromornithids' giant body and skull size. The presence of variation from other giant flightless birds, however, complicates interpretations regarding the influence of these factors and determining their independent effects remains difficult. Ultimately, the form of the dromornithid labyrinth is comparatively extreme. This likely resulted from the concordantly extreme broader suite of morphological and evolutionary traits that distinguish this family, even from other superficially similar birds.

§ Making waves in the fish-tetrapod transition: Non-destructive imaging techniques facilitate a deep dive into the tetrapodomorph fishes

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One of the most significant events in vertebrate evolution was the fish-to-tetrapod transition, along with other related transitions such as water-to-land, fin-to-limb and gill-to-lung. The impact and process of these events can be traced through observed morphological features and anatomical differences in tetrapodomorph fishes and basal tetrapods of the Devonian and Carboniferous periods. One lineage of these tetrapodomorphs is considered to be the common ancestors of tetrapods. However, many gaps in our knowledge of their anatomy and evolutionary history remain, particularly in relation to “internal” anatomy such as that of braincases and visceral elements, which are more rarely preserved. Here we introduce novel data on the anatomy and phylogeny of three tetrapodomorph fishes from the Arctic Circle and Antarctica. The tetrapodomorph *Koharalepis jarviki* is known from a single specimen comprising the cranial and pectoral regions, recovered from the Middle Devonian Aztec Siltstone of Antarctica. The external features of *Koharalepis* were previously described in 1991, then updated briefly in 2019 aided by synchrotron tomography. Here we present further descriptions of new internal anatomical features as revealed by neutron tomography. The medial face of the mandible is elucidated, as are the teeth and fangs. Other features shown for the first time include the gular, palatoquadrate, vertebrae, pectoral bones, braincase and its internal endocast. Seven partial skull specimens representing two new taxa have been uncovered from the Late Devonian Fram Formation in Nunavut, Canada. The fossils comprise five ethmosphenoid units and two oticooccipital units and appear to include soft tissues. The descriptions of these new taxa will double the number of tetrapodomorph fishes known from this site. Our results increase our understanding of tetrapodomorph evolutionary history by adding new information on tetrapodomorph internal anatomy, facilitating insight into intra- and inter-relationships between canowindrid, osteolepid and tristichopterid tetrapodomorph groups. The data presented here allows for a revision of tetrapodomorph phylogenetic relationships and will provide a greater understanding of the evolution of the wider tetrapod lineage.

§ New leptocleidid plesiosaur from the mid-Cretaceous northwest continental margin of Western Australia

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Plesiosauria is an iconic group of Mesozoic marine reptiles with a fossil record from every continent. They are well represented in the Lower Cretaceous sedimentary deposits of the Eromanga Basin in central–northeast Australia, particularly the upper Aptian–lower Albian Bulldog Shale of South Australia and the upper Albian Toolebuc Formation and Allaru Mudstone of Queensland, from which relatively complete specimens are known. By contrast, the fossil record of plesiosaurs from the western continental shelf margin of Australia is very sparse, with most specimens comprising only isolated skeletal elements. Here we describe the partial skeleton of a new leptocleidid plesiosaur from the middle Albian (upper Lower Cretaceous) part of the open marine Gearle Siltstone of the Giralia Range, Southern Carnarvon Basin, Western Australia. The specimen is referred to the clade Leptocleidia based on the prominent longitudinal trough on the lateral surface of the mandible and can be distinguished from all other leptocleidid plesiosaurs by a unique combination of mandibular, vertebral, and appendicular features. Phylogenetic analysis recovers the Gearle Siltstone plesiosaur as a leptocleidid, and sister to *Nichollssaura borealis* from the lower Albian Wabiskaw Member of the Clearwater Formation in Alberta, Canada. Leptocleidids had a global distribution during the Early Cretaceous, but their fossils do not stratigraphically extend beyond the upper Albian–lower Cenomanian. The Gearle Siltstone leptocleidid therefore represents one of the geologically youngest occurrences of the group. Furthermore, the unambiguous identification of leptocleidids in an offshore relatively deep marine depositional setting is significant, as these plesiosaurs

are otherwise almost exclusively known from more nearshore marine and non-marine environments, and have previously been interpreted as specialists for such palaeo-habitats.

*** Making fossils fun! A pipeline for the creation of interactive 3D-printed models from fossil material**

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Inspiring public interest and awareness is a core tenet of contemporary science. Increasing curiosity and engagement around subject matter, for academics, students, and the public alike, can be effectively achieved by use of props. Interactive props are particularly useful at fostering positive connection through playfulness and problem-solving. Here, we present a pipeline for creating 3D-printable puzzles from scanned fossil data using open-source Blender software. As one of the world's most unique and invaluable sources of fossilised vertebrate material from the Late Devonian period, Australia's Gogo Formation has provided extremely well-preserved specimens of the first jawed vertebrates—the armoured placoderms—which are usually characterised by bodies covered by large bony head and trunk plates. Based on one of these near-complete and 3D-preserved Gogo specimens, a generalised 'torosteid' arthrodire placoderm, we derived a set of 3D-printable plates from micro-CT data using a combination of established modifiers and modelling techniques available in Blender. These plates were in-fitted with magnets to produce a puzzle-style interactive prop, comprising more than 20 parts that click together to form a sturdy display in the semblance of Devonian placoderm armour. This kind of prop is likely to generate high interest from diverse audiences and is a valuable tool for display or interactive use during education and outreach initiatives.

Sizing up bite force allometry: Integrating the mechanical impact of cranial size on comparisons of absolute bite force

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In comparative Finite Element Analysis (FEA) of cranial bite force performance, standardised loading conditions are important for meaningful results. Typically, such standardisation involves controlling for skull size and often also mechanical advantage. However, if the question is how well skulls of varying shapes and sizes are capable of withstanding the bite forces required to bite the same food item, the effect of different skull sizes needs to also be retained to compare absolute bite forces. In this study, we apply FEA to 13 skulls from potoroids, a radiation of small kangaroo relatives exhibiting variation in both skull size and mechanical advantage. Our simulations reveal that the three standardisation strategies yield at times markedly different estimates of cranial stress and strain. We propose that each approach aligns with a different research question, based on separate muscle-scaling approaches: (1) to purely compare how effectively different skulls transmit muscle force to the bite point, muscle force is scaled relative to skull size; (2) to compare structural adaptations for biting purely based on cranial geometry, size-corrected bite simulations are also scaled to standardise mechanical advantage; and (3) to compare how different skulls bite an identical food item, muscle forces are scaled to produce identical bite reaction forces. Using these frameworks, we demonstrate that the short-faced desert rat-kangaroo (*Caloprymnus campestris*)—with its biomechanically efficient short skull—would be predicted to tolerate harder bites than the long-nosed potoroo (*Potorous tridactylus*) under conventional standardisation of size and mechanical advantage. But after also standardising absolute bite reaction forces, the larger skull of the potoroo results in comparable mean brick stress between the two species. Taking this scaling into account is crucial when species are compared in the context of feeding behaviour, niche differentiation, and interactions with real food items.

*** Genestreaming Sculptures National Tourism Trail. Communicating an awareness of the deep time history of our continent, its cultures and recent conservation efforts**

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Our team constructs giant evolutionary trees as public artworks that we call Genestreaming sculptures, <https://sciart.com.au/genestreaming-journey-sculptures-nation-wide-tourism-trail-an-introduction/>. The foundation for any given project is to select species from the region in question and then research their shared ancestry through the construction of a phylogenetic tree. The purpose of this public art program is to broaden an awareness in the general community of the deep-time stories that have been discovered and are being discovered in this incredible continent alongside cultural and conservation components. Coupled with augmented reality technology, which we use to provide a deep-time understanding of the history of the Earth, this initiative is focused on connecting visitors with an experience of the tree of life and the geological time scale. When people enter a sculpture, they are walking back through the geological time scale and can see where humans share common ancestry with 15 selected species from a specific region. The project has its origins in Tree of Life virtual reality teaching tools developed at ANU that were altered when an opportunity was offered to use them as the foundations for a public art program, which combined scientific illustration, field naturalist studies and First Nations art. Our team is seeking to connect more directly with the palaeontological community to share the palaeontological research that is being conducted across Australia through specific sculpture projects.

Mitochondrial genomes clarify the historical range and population history the Plains Mouse (*Pseudomys australis*)

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Unstable taxonomy and lack of well-provenanced historical records have hindered our understanding of the former geographic range, population structure, and habitat preferences of species that have undergone recent declines and range contractions. The Plains Mouse (*Pseudomys australis*) is a native rodent that exemplifies this issue. Once found over much of southern Australia, it is now restricted to the western gibber plains of the Lake Eyre Basin, and recently, the sand dune country of the north-eastern Strzelecki Desert. Subfossil bones in Late Pleistocene to Holocene cave deposits across southern Australia suggest a much broader pre-colonial distribution. Previous authors have noted distinct morphological variation within *P. australis* across its historical distribution, having been synonymised with *P. auritus*, *P. rawlinnae* and *P. minnie* to form the *P. australis* species complex. Here we aimed to test the hypothesis that specimens assigned to *P. australis* across southern Australia belonged to distinct sub-species with discrete distributions. To test this hypothesis, we generated mitochondrial genomes from subfossil bones, historical skins, and modern tissue from 42 specimens. All 42 genomes formed one monophyletic clade which suggests samples morphologically assigned to *P. australis* across its historical distribution belong to a single species. We found shallow and geographically unstructured phylogenetic diversity that confirms the very broad range of *P. australis* from the western Nullarbor (WA), through South Australia, and into Queensland. These results suggest that *P. australis* originally lived across a diverse range of mesic, semi-arid and arid habitats, with a dynamic population history consistent with its known irruptive biology. A loss of haplotype diversity in modern *P. australis* compared to sub-fossil samples is consistent with known range contractions and population extinctions. Our results contribute to our understanding of the ongoing impacts of European colonisation on small rodents in southern Australia.

*** The secrets behind continuous tooth replacement in reptiles**

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While humans only replace their teeth once, most reptiles have the ability to continuously replace their teeth, known as polyphyodonty. One of the limitations behind tooth replacement is the amount of available space in the jaw, regulated via mechanical feedback that determines whether the next tooth generation will initiate or not. This spatial pattern in polyphyodonts is not random, with teeth generations appearing in “wave-like” formations. Polyphyodont reptiles, such as snakes and lizards, provide an opportunity to quantify spacing between tooth positions and tooth families. We aim to identify whether the identity or size of each tooth correlates with spatial patterns between teeth of the same family (intergenerational), and between teeth of the same generation but different families (interfamilial). Using 3D-scanning and modelling, we have measured the 2D-interfamilial and intergenerational distances between teeth of adult specimens of the ocellated lizard (*Lacerta lepida*), ocelot gecko (*Paroedura picta*), and corn snake (*Pantherophis guttatus*), as well as 3D-volumes of teeth as a proxy for tooth size. In addition, the veiled chameleon (*Chamaeleo calypttratus*) was used as an out group as, unusually for lizards, it has no tooth replacement. We also used immunofluorescence to look at gene expression related to spatial feedback between developing teeth. We found that intergenerational and interfamilial distances between teeth followed linear size patterns, but that tooth size did not strongly correlate with spacing. We found that genes associated with apoptosis and tooth attachment facilitate tooth succession in reptiles. Having recognised these patterns, we can now use them to estimate tooth position and number of tooth generations in fossil taxa, for example, to predict when continuous tooth replacement was lost in early mammals.

***§ Taxonomic tools: Geometric morphometric assessments of Australian Cenozoic Neoceratodontidae**

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The Australian lungfish (*Neoceratodus forsteri*) is the only extant member of Neoceratodontidae, and is distributed in relict habitat throughout South-Eastern Queensland, Australia. Conversely, the Australian fossil record of Dipnoi (lungfish) indicates that throughout the Palaeozoic, Mesozoic, and Cenozoic, lungfish were a species-rich group with a wide distribution. Previously, assessments of Cenozoic lungfish diversity have been limited to qualitative descriptions of tooth plates, and quantitative methods of geometric morphometrics have not been undertaken, due to low sample sizes. This study aims to quantify the shape of Cenozoic lungfish tooth plates and determine if tooth plate shape is significantly different between species, tooth plate position, location, and ontogeny. The specimens assessed will include lungfish tooth plates from, extant *Neoceratodus forsteri*, ($n = \sim 1$), Lake Eyre Basin fossils (Katipiri Formation, Late Pleistocene, ~ 124 Kya) ($n = 40$), and Lake Pinpa fossils (Namba Formation, Late Oligocene, 25.5 Mya) ($n = 60$). Specimens will be photographed in occlusal and ventral views, providing a 2D image for landmarking. Landmarks will be placed on the most labial tips of ridges one to four, the mesiolingual corner, and the most posterior ridge tip. Landmarks will be aligned using a Procrustes Superimposition, and then a Principal Component Analysis will be conducted to visualise data. A Multivariate Analysis of Variance will then be conducted on response variables of superimposed landmarks and principal components by factors of tooth plate position (upper, or lower), location (Waralamanko Waterhole, Lake Pinpa, or Queensland), ontogeny (non-breeding, adult, or large adult), and species. It is hypothesised that a significant difference in tooth plate shape will occur between age classes, due to tooth plate growth continuing throughout the lifetime, and provide insight into taxonomic identification. This study will increase the understanding of Cenozoic Australian lungfish tooth plate shape variation, providing insights into the past diversity, and extinction trends of Australia’s unique fauna.

§New flamingo fossils from the Oligocene of central Australia illuminate the early evolutionary history of Phoenicopteriformes

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Flamingos (Phoenicopteriformes) are widespread, gregarious water birds with a near-global distribution. The fossil record for this order includes representatives of the family Phoenicopteridae (true flamingos) and the extinct family Palaelodidae, which share morphological and palaeoecological similarities with flamingos but are still poorly understood. Understanding the relationship of these two families is crucial for revealing the early evolutionary history of flamingos. Surprisingly, fossils reveal that both families once lived in Australia, with Phoenicopteridae having a notably long record that spans the late Oligocene to the late Pleistocene. The late Oligocene record for these families includes specimens from the Etadunna Formation, which represent two extinct flamingos *Phoenicopterus novaehollandiae* and *Phoeniconotius eyrensis*, and two palaelodids (*Palaelodus pledgei* and *Palaelodus wilsoni*). Here we present new material of these four species from the late Oligocene Namba Formation, which expand their known geographic ranges, help to resolve the taxonomic status of these species, and support a close relationship between Palaelodidae and Phoenicopteridae. The new data confirm that the four species are indeed taxonomically distinct and show that *Phoeniconotius eyrensis* shares distinct features with both Palaelodidae and Phoenicopteridae. These shared features of *Phoeniconotius eyrensis* suggest a close relationship between Palaelodidae and Phoenicopteridae.

§Marine vertebrate assemblage and trophic interactions of the Early Cretaceous (Aptian–Albian) Eromanga Basin

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During the last ~20 million years of the Early Cretaceous (Aptian–Albian; ~121.4–100.5 Ma), much of central Queensland was occupied by the epeiric Eromanga Sea. Extensive sedimentary sequences were deposited within the Eromanga Basin throughout this timeframe. The dominant macropredators within the Eromanga Sea pelagic ecosystem were marine reptiles including protostegid sea turtles, ophthalmosaurian ichthyosaurs, elasmosaurid, cryptocleidid, leptocleidid, polycotyloid and brachauchenine pliosaurid plesiosaurs. Probable apex predators include the brachaucheniine pliosaurid *Kronosaurus queenslandicus*, which achieved lengths of up to 11 metres, and massive cardabiodontid sharks that potentially reached up to ~8 m. The Eromanga Sea ecosystem also incorporated a diversity of larger-bodied actinopterygians, chondrichthyans, and cephalopods. Previous research has proposed a climate-coordinated faunal turnover across the Aptian/Albian boundary: the later Aptian being marked by cold to possibly freezing conditions at higher palaeolatitudes; whereas the Albian records increasingly warmer climates and epicontinental marine regression with restricted basin, stratified water column, and persistent benthic dysoxia. These events were tracked by wholesale replacement of macroinvertebrate communities, and a proliferation of previously scarce larger-bodied sharks and actinopterygians, coupled with the disappearance of cryptocleidids and leptocleidids and the influx of polycotyloids and protostegids. Here, we compare the trophic composition of assemblages from major vertebrate fossil bearing rock units throughout the Eromanga Basin to pinpoint potential ecosystem changes and quantify faunal turnover. We aim to clarify the extent of climate change impacts on the Eromanga Sea biotas, and the corresponding roles of transgressive–regressive cycles and global oceanic anoxia events during the mid-Cretaceous.

§ A toothed platypus from the Early Pleistocene of southeastern Australia

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Platypuses of the Oligocene–Miocene genus *Obdurodon* possessed teeth as adults, whereas the living platypus (*Ornithorhynchus anatinus*) does not. The depauperate platypus fossil record inhibits our understanding of when and why this ‘tooth loss’ occurred. *Obdurodon* comprises three known species, *Ob. insignis* from the late Oligocene Etadunna and Namba Formations of northern South Australia, and *Ob. dicksoni* and *Ob. tharalkooschild* from the Middle Miocene of Riversleigh in northern Queensland. Here we report on new dental specimens referable to *Obdurodon* from Early Pleistocene fluviolacustrine deposits in southwestern New South Wales. This unexpected discovery extends the temporal range of *Obdurodon* by around 14 million years, and the known geographic distribution of *Obdurodon* into southeastern Australia. The persistence of *Obdurodon* into the Pleistocene points to unforeseen temporal overlap with *Ornithorhynchus*, suggesting a divergent ecology and that platypus evolution during the Neogene was more complex and not as linear as previously thought.

Building flippered friends in 3D: Mathematical modelling morphing madness!

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Many of our aquatic friends are equipped with flippers and fins; they use them to navigate, hunt, and thrive in the waters of our planet. Joining a vast and varied array of fish, eight distinct groups of tetrapods have transitioned to life in the sea, and they all evolved flippers along the way! This study explores whether correlations exist between flipper shapes and overall body shapes. The eight tetrapod groups being examined are: extant penguins, cetaceans, pinnipeds, sirenians, and sea turtles and the extinct sauropterygians, mosasaurs, and ichthyosaurs. Additionally, the fin shapes of Chondrichthyes species serve as a control group, demonstrating a highly similar functional structure that did not evolve from a tetrapod limb. Given the challenges of physically 3D-scanning all the species from each group within the limits of this project, could we instead create mathematically determined 3D-models of these animals? This presentation introduces a technique developed by the presenting author in Blender to achieve this. By taking the silhouette curves of bodies and flippers and integrating them with a specially designed vertex 'Skin' modifier, this method can build models of penguins, whales, sea turtles, and more. The vertices from these models can be morphed from one to another from animation and science communication, and the complete set of points for each model can be imported and utilised in geometric morphology software as a genuine set of 'landmarks'. Join us as we dive deep into the fascinating realms of Blender and marine locomotion!

§A new Miocene–Pliocene genus sheds light on the origins of rock-wallabies and pademelons

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Molecular evidence points to an initial phase of diversification among macropodine kangaroos in the Middle–Late Miocene, but two species of the plesiomorphic dorcopsin clade are the only Late Miocene macropodines yet described. This poor record has obscured our understanding of the early evolution of the lineages that came to occupy medium-sized herbivore niches in modern Australian ecosystems, including rock-wallabies (*Petrogale*) and pademelons (*Thylogale*). At present, the phylogenetic proximity of these taxa is well supported by molecular data, but only weakly by morphological and palaeontological evidence. Here we report on a new genus with three new species from Late Miocene and Late Pliocene deposits in southern and eastern Australia that share a mix of craniodental and postcranial attributes with species of *Petrogale* and *Thylogale*. Our parsimony analysis places the new genus in a clade with *Petrogale* and *Thylogale* that forms the sister taxon to the Macropodini. This result provides the first

robust fossil and morphological support for a close relationship between *Thylogale* and *Petrogale*. The new genus exhibits a mosaic of features more reminiscent of *Thylogale* in overall proportions, but with more gracile, *Petrogale*-like hindlimbs. Overall, this could suggest adaptation to denser shrubland habitats, with a functional balance between manoeuvrability and strength. The co-occurrence of two species in the Late Miocene Curramulka Local Fauna represents the earliest fossil evidence for macropodine kangaroos outside of the Dorcopsini, and sheds light on a key early stage of macropodine diversification.

***§ Australia's oldest crocodylian eggshells: Insights into the reproductive biology of mekosuchines**

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The vanished mekosuchine crocodylians, together with large madtsoiid snakes, the largest known lizards, thylacoleonid marsupials, and a range of other terrestrial carnivores, were among Australia's most significant predators throughout much of the Cenozoic. Although aspects of mekosuchine reproductive biology (including eggshells, eggs, clutches, or nests) have previously been reported, they have not been formally investigated. Here, we describe the oldest crocodylian eggshells known from Australia, recovered with the lower Eocene Tingamarra Local Fauna from within the Oakdale Sandstone at Murgon, south-eastern Queensland. The eggshells are well preserved and represent a new type of crocodylian eggshell. Given the abundance in the Tingamarra deposits of two mekosuchine species, both referable to the genus *Kambara*, and the absence of any other crocodylians, it is plausible that the eggshells were laid by one or both of these species. A preliminary taphonomic assessment of the oological material provides new insights into mekosuchine reproductive behaviour.

§A new species of dactylopsiline possum (Diprotodontia: Petauridae) from the Oligo-Miocene deposits of the Riversleigh World Heritage Area, Queensland

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Within the possum family Petauridae is the subfamily Dactylopsilinae, members of which are commonly referred to as striped possums or trioks. Today, dactylopsilines are found throughout New Guinea and surrounding islands, and one species (*Dactylopsila trivirgata*) is found in rainforests in north Queensland, Australia. This distribution has led to the assumption that the subfamily arose and diversified within New Guinea, gradually spreading out to small islands and the northernmost part of mainland Australia. The Riversleigh World Heritage Area in northwestern Queensland has produced a great deal of petaurid material. This includes several partial dentaries from Early Miocene sites that represent a new species of dactylopsiline possum. *Dactylopsila* species 1 has been assigned to Dactylopsilinae and described as a new species on the basis of morphological comparison of the dentaries and lower dentition with other petaurids. Statistical analyses of dental measurements provide quantitative support. The discovery of *D.* species 1 indicates that the subfamily evolved on the Australian mainland, though it is still unclear whether *D. trivirgata* represents an early radiation of the subfamily that never left Australia, or a more recent colonisation from New Guinea after earlier Australian dactylopsilines died out. *Dactylopsila* species 1 also represents an early step in understanding the evolutionary history of the Petauridae. While there is a lot of fossil petaurid material known, very little of it has been described. Description and analyses of extinct petaurids such as *Dactylopsila* species 1 will increase understanding of both the origins of the family and of the diverse environment they evolved in.

§ Bite club: Canine tooth structure and function in aquatic mammals

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Over the last 250 million years, many different animal groups have independently evolved adaptations to living in water. For predators, the functional demands of aquatic life necessitated changes in prey capture, leading to the evolution of new feeding styles and anatomy. Canine teeth are essential tools for feeding, and in terrestrial carnivores, there are well-established links between their form and function. However, it is unclear whether these patterns hold in aquatic mammals, such as otters or seals. We conducted a combined analysis of canine tooth shape and biomechanics on a sample of 215 teeth representing a broad range of terrestrial, semi-aquatic and aquatic mammals. First, we used geometric morphometrics to quantify tooth shape, then tested for associations between shape and feeding style. Next, we assessed the biomechanics underlying these associations by performing finite element analyses to model stress and physical puncture tests to quantify puncture force. Shape analysis indicates that suction feeders have robust, curved canines, while raptorial species have straighter, thinner canines. Biomechanical testing demonstrates that the canines of raptorial species penetrate more easily but are more fragile than those of suction feeders. These patterns can aid in understanding the feeding biology of difficult-to-observe and extinct marine species.

* Chronovarium: A deep-time choose-your-own adventure

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This poster presents “Chronovarium”, an interactive artwork that explores ideas of palaeoecology, sedimentology, and how land and seascapes as we see them now are formed by the history of their changes through time. This artwork is freely accessible online (<https://chronovarium.com>), with a QR code to be displayed on our poster. Our aim was to create an interactive digital tool for palaeontological teaching and outreach that communicates concepts of deep-time environmental change and continuity in visually appealing manner that is accessible to a broad audience. In this choose-your-own-adventure artwork, you are presented with an illustrated spherical vivarium containing a miniature ecosystem, populated by Australian plants and vertebrate inhabitants. At each stage, you are presented with a decision between two choices—for example, “increase rainfall” or “decrease sea level”—leading to an altered ecosystem. Each choice leaves traces of the previous stage within the vivarium, visible as stratigraphic layers and fossils that accumulate in the sediment at the dome’s base. The final stage of the artwork displays a sediment core that records the history of these changes with a description of the fossils left behind. For audiences without a palaeontology background, it can often be easier to conceptualise processes happening over broad spaces but harder to do the same over long timespans. By centring this artwork on a vivarium, this piece restricts the spatial scale to a miniature ecosystem, drawing focus instead to the dimension of time—particularly how choices and changes affect systems in the long term, and how these changes are recorded in the sedimentary and fossil records. We foresee this artwork being applied in teaching and science outreach and are currently working on developing it as a teaching resource aligned with Australian curriculum learning outcomes. We welcome opportunities for collaboration and future incorporation into teaching and community outreach.

§ A new unusual crested anhanguerian (Pterosauria, Pterodactyloidea) from the late Early Cretaceous Toolebuc Formation, Eromanga Basin, Australia

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Anhanguerians were the most diverse and abundant pterosaur clade during the Early Cretaceous with an inferred cosmopolitan distribution based on specimens reported from Brazil, Morocco, China, the United States, England, Spain and Australia. Although they are the most common pterosaurs reported from Australia, their morphological diversity is poorly understood because the Australian pterosaur record primarily comprises isolated and fragmentary remains. Our understanding of their anatomy has improved within recent years through the description of two partial skeletons from the Eromanga Basin; however, the cranial material associated with these specimens is incomplete. A new anhanguerian skull missing the mandible is presented here. The cranium is complete bearing both premaxillary and parietal crests; however, almost all the alveoli are vacant and some elements, such as the anterior end of the rostrum and jugal are broken and disarticulated. The general morphology of the parietal crest strongly resembles that of *Ludodactylus sibbicki* from the Aptian Crato Formation (Araripe Basin, Brazil). Despite this similarity, preliminary phylogenetic results place the new Australian pterosaur within the less inclusive Anhanguerinae as sister to *Liaoningopterus gui*, a taxon with a comparatively small premaxillary crest, lacking preserved parietals. This is a somewhat surprising result, given that all other anhanguerines which preserve parietal crests (*Caulkicephalus*, *Ludodactylus*, and *Guidraco*) form a clade. Taken together, the new Australian pterosaur constitutes the first evidence of Anhanguerinae in Australia and provides additional support for faunal interchange within the Eromanga Basin alongside an endemic radiation of Australian anhanguerians during the late Early Cretaceous.

*§ Highlighting the importance of key fossils and assemblages through impactful science communication

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The future of palaeontology depends on effective engagement with diverse audiences. This includes cultivating curiosity among students, building public trust in science, and ensuring policymakers recognise the cultural and scientific importance of these discoveries. However, communicating the value of key fossils, assemblages and deposits is often difficult through peer-reviewed papers, which are often laden with jargon and locked behind paywalls. Whilst photo-realistic reconstructions and digital models are effective vehicles for sharing morphological and ecological information outside academia, their impact can be enhanced through story-telling elements and playful characterisation. This approach draws on principles supported by behavioural and communication studies, which highlight the importance of emotional connection in fostering engagement and lasting impact. By adapting principles from Zoos Victoria's Connect-Understand-Act (CUA) model, our approach emphasises that sparking curiosity and empathy is a necessary first step before audiences are ready to support or advocate for the protection of sites and species. Here we present a series of scientifically grounded illustrations created for permanent and temporary exhibitions primarily based on keystone species from the upper Albian Toolebuc Formation of the Eromanga Basin, Queensland, as well as the upper Miocene–lower Pliocene Sandringham Sandstone of Beaumaris, Victoria. Through collaboration between scientists and artists, these characters and scenes draw on recent research, combining anatomically accurate gross morphology with added elements of caricature, emotion, and narrative. The resulting artworks foster relatability, evoking an emotional response from the audience and facilitating more meaningful engagement with key scientific concepts. By creating engaging and accessible characters, these illustrations simultaneously increase public awareness and communicate complex ideas to diverse audiences. This form of science communication not only benefits scientists sharing their work through social media, but provides museums, research institutions, and not-for-profit organisations with tools for developing exhibitions, outreach materials, and merchandise.

Late Miocene–Pliocene diversification of macropodines and broader turnover among marsupial terrestrial herbivores

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Kangaroos and their relatives diverged from possum-like ancestors and descended from the trees into terrestrial or semi-fossorial foraging niches prior to their oldest fossil records from the Late Oligocene (~25 Ma). However, the most recognisable and speciose sub-family, Macropodinae, did not appear until the late Miocene. In this study, we have sequenced complete mitochondrial genomes and eleven nuclear loci to further elucidate the evolution of macropodines. Among the three macropodine tribes, the New Guinean forest wallabies (Dorcopsini) diverge from the base of Macropodinae, leaving Dendrolagini (pademelons, rock-wallabies and tree kangaroos) as sister to the open habitat Macropodini (*Onychogalea*, *Setonix*, *Lagorchestes* and the ‘*Macropus*’ clade). Macropodine diversification has been linked to open habitat expansion closely following the Middle Miocene Climatic Optimum. Our molecular dates place macropodine diversification five million years later (from ~8.5 Ma), concurrent with increasing aridity and habitat heterogeneity, and in concert with the decline of all but the largest (or burrowing) vombatiform terrestrial herbivores. The most prominent spike in macropodine diversification, which includes the ‘*Macropus*’ radiation, coincided with initial graminoid expansion during the Early Pliocene (~4.5 Ma). We consider how faunal turnover among macropodiform and vombatiform terrestrial herbivores may have been facilitated by environmental changes shifting the balance of competition between species. We will also highlight a new method we have developed and applied to macropods for discretising 3D-shape variation to exploit both the objectivity of continuous data and the phylogenetic modelling power of binary and multi-state characters.

The first Australian rhynchocephalian...?

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The last surviving constituent of the lepidosaurian clade Rhynchocephalia is the tuatara of New Zealand (*Sphenodon punctatus*). Rhynchocephalians originated in the Middle Triassic, achieved a worldwide distribution during the Late Triassic, and thrived and diversified to occupy a range of ecological niches throughout the Jurassic. During the Early Cretaceous, they became increasingly restricted to the Gondwanan supercontinent, such that their Late Cretaceous record is almost entirely confined to South America. The only confirmed post-Mesozoic fossil evidence of Rhynchocephalia derives from the Paleocene of Argentina and the Miocene–Holocene of New Zealand. From a palaeobiogeographic perspective, it would not be surprising to find evidence of rhynchocephalians in Australia, especially in Mesozoic strata. And yet, fossils have heretofore not been forthcoming in rocks of any age on the Australian continent. In 2024, a possible rhynchocephalian jaw fragment was identified from the mid-Cretaceous (~100–95 Ma) Winton Formation of Queensland, northeast Australia. Superficially, the prospective teeth appear firmly fused to the jaw (acrodont implantation), with apparent wear facets from tooth–tooth occlusion or tooth–food contact. However, micro-CT scans of the specimen reveal no evidence of internal differentiation, let alone enamel, dentine, or bony texture. If this specimen does indeed represent a rhynchocephalian jaw, then its internal structure was obliterated during its fossilisation, perhaps in a process akin to opalization. Destructive geochemical analyses on the prospective Winton Formation rhynchocephalian would potentially elucidate its preservation pathway. The results of this would either demonstrate that it is not a rhynchocephalian, or remove one potential impediment to accepting it as one. Undertaking destructive analyses on such a rare specimen would be undesirable; however, numerous other fossils that appear to show a similar preservation mode have been found at the same site. One or more of these might be able to be sacrificed to achieve this aim.

Megafauna at the water's edge: A Late Pleistocene *Diprotodon* site and extinction insights from the Pilbara, Western Australia

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The causes of the late Quaternary extinction of Australia's megafauna remain contentious, with debate centring on the relative roles of climate change and human impacts. Resolving this requires robust records of species' final occurrences, taphonomic histories, and palaeoenvironmental contexts. Here we take a fresh look at a Pleistocene vertebrate assemblage from Du Boulay Creek in the Pilbara region of Western Australia. Fossils of vertebrates including the enormous marsupial *Diprotodon optatum* have previously been reported, but few details of the site, its formation, and precise age have been documented. Our field investigations have revealed a series of extensive bonebeds of *D. optatum*, along with other extinct megafauna, found in association with rhizoconcretions, marine invertebrates, and sedimentary features indicative of former intertidal mangrove environments. The fossiliferous layers occur at several distinct elevations above modern mean sea level, consistent with accumulation during multiple Late Pleistocene sea-level high-stands. This is the only known Australian fossil site where large-bodied terrestrial vertebrates accumulated within mangrove habitats, and one of only a few globally where such taxa have been preserved in similar environments. The Du Boulay Creek assemblage expands the known environmental range of several megafaunal taxa and provides rare insight into coastal habitats occupied by these giants during the Late Pleistocene. These findings have important implications for reconstructing species' ecological tolerances, refining extinction chronologies, and understanding the range of environments in which the final populations of Australia's megafauna may have persisted.

A strange new kangaroo from the Pleistocene of southern Australia

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Kangaroos and wallabies have been the main medium- to large-bodied mammalian herbivores in Australia for at least the past six million years. Their fossil record has been as well studied as that of any marsupial group. Yet, even in deposits dating to as recently as 50 thousand years ago, we are still discovering evidence of species with highly distinctive morphologies. Here we report on the newest addition to the Pleistocene bestiary, a species of *Baringa* that is the most abundant large mammal in the assemblages of the Thylacoleo Caves, south-central Australia, and is also known from Lake Callabonna, northeastern South Australia. It is represented by complete skulls and skeletons of different ontogenetic ages. Among its singular features are enlarged first incisors, relatively large eye orbits that have square prominence above them, three-thumbed hands with long, hooked claws, and a hindfoot capable of a high degree of flexion. To date, we have brainstormed a range of ecomorphological hypotheses: the species was semiarboreal, was suspensory like a sloth, walked along branches like a chameleon, burrowed, grappled with competitors using its overengineered hands, or was just an ordinary kangaroo with some extraordinary features. None of these make sense of the whole picture, which highlights that, in palaeontology, sometimes it is easier to tell a story with fewer data. Still, one thing is clear: when people first arrived in Australia, kangaroos had a far broader range of adaptations and filled a greater array of ecological niches than previously imagined. Resolving what all these species did and the ecological impacts of their extinction will take some time and effort to unravel.

*** Exploring reptilian scale morphology as a proxy for dinosaur skin colouration**

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Reconstructing the colour of long-extinct organisms preserved in the fossil record is among the most recent developments in palaeontology. Currently, the only available method relies on recovering and evaluating the morphology of preserved pigmentary organelles (melanosomes) from fossilised integuments. This approach works well on fossilised feathers but is limited when applied to scaled dinosaurs. Here, we tested whether reptilian scale morphology correlates with colour using an extant model, *Crocodylus* ($n = 8$). We collected data along body transects (forelimb, hindlimb, and tail) in three species: *C. johnstoni*, *C. novaeguineae*, and *C. porosus*. Colour was defined along red, green, and blue (RGB) gradients and divided into two datasets: monochromatic and dichromatic, each describing primary (background) colour. Morphology was defined categorically, describing shape (e.g., polygonal vs quadrangular) and osteodermal association (epiosteodermal vs non-epiosteodermal). An ANOVA analysis found a significant correlation between scale morphology and each of the red, green, and blue gradients for the body, forelimb, hindlimb, and tail in primary colour, particularly between polygonal and quadrangular scales, and epiosteodermal and non-epiosteodermal scales. Monochromatic and dichromatic datasets yielded similar results. When applied and compared to the scales of extinct crocodylians (*Macrospodylus bollensis*) and non-avian dinosaurs (e.g., *Borealopelta markmitchelli* and *Psittacosaurus* sp.), our findings align with melanosome-based pigmentation observations (e.g., countershading). While further scrutiny and wider sampling is needed, these results demonstrate that scale morphology can offer insights into integument colouration patterns in the absence of preserved melanosomes.

***§ Navigating the night: Ecomorphological adaptations in the inner ears of bats**

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Echolocating bats possess a sophisticated audio-vocal system for emitting and perceiving ultrasonic sound (20–212 kHz). This biosonar system enables bats to navigate and forage, often in complete darkness. This unusual ability has evolved through structural modifications of the inner ear—such as an enlarged cochlea, an increased number of spiral turns and a longer basilar membrane relative to non-echolocating bats and other mammals. Given that these structural modifications underpin high-frequency hearing and, thus, echolocation in bats, exploring these adaptations may provide insights into the evolutionary origins of echolocation in Chiroptera. Moreover, the variation of inner ear morphologies may uncover how this unique sensory system has enabled bats to diversify and occupy a broad range of ecological roles and dietary niches. For my PhD, I will explore how echolocation, habitat preference and foraging behaviour influence cochlea shape variation in bats. I will obtain linear measurements of the inner ears from μ CT scans. I will also generate endocasts of the cochlea to perform 3D geometric morphometric analyses. This knowledge could contribute to understanding community structure and habitat boundaries and applied to the fossil record, may provide insights into habitat preference and echolocation capabilities in extinct bats.

Ancient DNA and morphometrics reveal a new species of extinct insular shelduck from Rēkohu Chatham Islands

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The Rēkohu Chatham Islands, 785 km east of mainland Aotearoa New Zealand, have a rich biological heritage. However, much of the biodiversity that occurred at the time of human arrival ca. 1450 CE is now extinct—for example, there was a speciose waterfowl community, with eight known native species, of which only one remains. Archaeological and subfossil bones of a tadornine shelduck from Holocene sand dune deposits on the archipelago have long been suspected to be a distinct species. We used palaeogenetic and geometric morphometric techniques to reconstruct the evolutionary history of this shelduck. Mitogenomes showed the ancestors of the Chatham form arrived on the islands ~330 Kya and is most closely related to the mainland New Zealand pūtangitangi paradise shelduck *Tadorna variegata*. Geometric morphometric analysis indicated that the Chatham form had a larger skull, short robust wings, long robust legs, and was flight reduced. Our data support recognition of the Chatham form as a distinct species Rēkohu shelduck *Tadorna rekohu*. Working with Indigenous communities is paramount if we are committed to decolonising palaeontology, especially for legacy projects and those involving historically collected material. The shelduck's scientific and common names were gifted by the Hokotehi Moriori Trust, who are the tchieki (guardians) of Rēkohu biodiversity, with which they are interconnected through shared hokopapa (genealogy). The Rēkohu shelduck adds to the rich waterfowl assemblage of the archipelago and illustrates the speed at which 'island syndrome' effects can occur in insular lineages.

* North to south or south to north: The dispersal direction of some Australian mammalian groups?

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Beginning at least in 1876 when Alfred Russel Wallace speculated on the biogeography of major mammalian groups in his seminal work, "The Distribution of Animals, with a study of the Earth's Surface", the view has been consistent among biogeographers that the major groups of terrestrial mammals originated in the Northern Hemisphere and dispersed to the southern. These dispersals are thought to have occurred in the Mesozoic. Given the preponderance of relevant fossils in the Northern Hemisphere during that era and the few from the Gondwana continents of that time, this hypothesis has been seen to be further strengthened during the past century and a half with the collection of additional specimens. However, a handful of fossils discovered in the Southern Hemisphere during the past quarter century, suggest that caution may be warranted. In the Early Jurassic of Argentina, fossils of stem therians (four lower jaws plus possibly one upper premolar) occur 50 million years earlier than undoubted therians (marsupials and placentals) in the Northern Hemisphere. Cimolodontan multituberculates are the most common Late Cretaceous mammals in the Northern Hemisphere and persist there until the Eocene. The oldest undoubted cimolodontan occurs in the late Early Cretaceous of Australia (two lower jaw fragments), about 8 million years prior to their first appearance in the Northern Hemisphere. Either way, dispersal between South America to North America presumably was across the Panamanian region. From Australia to Asia, dispersal may have been by island hopping as Australia was much further south in the late Mesozoic than at present. Whether less than a dozen fossils is a harbinger of a replacement of a well-established biogeographic hypothesis will only be known when further specimens in the Southern Hemisphere come to light.

*** Resurrecting a *Manu* from the past: An ancient seabird conundrum solved**

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The Waitaki region in the Te Waipounamu South Island of Aotearoa New Zealand has a diverse record of fossil seabirds recovered from its late Oligocene–earliest Miocene sequence of carbonate shelf deposits. Ten species (and more undescribed) make up the raft of penguins reported from this period locally, from those of the tiny fairy penguin-sized *Pakudyptes* to the giant *Kairuku*, standing 1.3 metres tall. Over a relatively short interval (~27–22 Ma), the wing bones of these species show a dramatic evolutionary shift from the musculoskeletal system typical of the late Eocene to one close to that of crown Sphenisciformes. Due to preservational biases, other seabirds are represented only by the associated skeleton of a small albatross (*Plotornis*) and various undescribed isolated bones from other members of Procellariiformes. But there is one other species whose relationships have remained a mystery for 80 years—*Manu antiquus*. The enigmatic seabird *Manu antiquus* was described by University of Otago Zoology Professor Brian Marples in 1946 from a furcula recovered from the Kokoamu Greensand near Duntroon, Duntroonian NZ Stage (late Oligocene; mid-Chattan). The specimen (OM GL1519) is housed in the Tūhura Otago Museum collection, Ōtepoti Dunedin, alongside other fossil vertebrates (penguins, whales, dolphins) that Marples recovered during his early 20th-century fieldwork across the Waitaki region. Speculation has ranged on whether the specimen is an albatross or a pelagornithid, though current consensus is that the specimen is of uncertain affinity. Based on an assessment of the nature of the discovery and anatomical comparisons, the material is deemed consistent with that of sphenisciforms, with implications for the taxonomy of other described fossil birds from the region.

***§ Accounting for phylogenetic uncertainty reveals diverse evolutionary dynamics of centroid size in marsupials**

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This study investigated the evolutionary dynamics of centroid size in a representative sample of modern marsupials. For this purpose, we used a dataset from Weisbecker et al.'s 2021 paper which included 57 species from all seven major marsupial orders. The specimens were already landmarked, providing a consistent basis for comparative analyses. Our aim was to assess how phylogenetic uncertainty, represented by different chronograms, impacts the inferred evolutionary parameters. To achieve this, we fitted a suite of comparative phylogenetic models—including Brownian Motion (BM), Ornstein-Uhlenbeck (OU), Lambda (λ), Delta (δ), and Early Burst (EB)—to four distinct timelines. These included: two Beck trees (a 2022 total evidence tree and a 2014 morphology-only Bayesian tree), a Duchêne phylogenomic time tree (2017), and a newly constructed molecular phylogeny, calibrated using pre-processed molecular data from the Oz Mammals Genomics (OMG) consortium, developed as part of my PhD project. All trees were pruned to include only species of interest. Model selection was performed using the Penalized Bayesian Information Criterion (pBIC). The results consistently show that centroid size evolution has a strong phylogenetic signal, as the Lambda model provided the best fit for all chronograms. However, the analysis of the OU model shows dramatic variation across trees. For instance, the Beck 2022 tree inferred a very low α value (≈ 0.03), suggesting a BM-like evolution. In contrast, the Duchêne and OMG trees showed a high degree of stabilizing selection ($\alpha \approx 2.7$), while the Beck-2014 tree showed a moderate degree ($\alpha \approx 0.44$). These findings highlight the importance of choosing a phylogeny to account for phylogenetic uncertainty and how it can substantially alter biological conclusions about the tempo and mode of trait evolution.

*§ An analysis of the function of papilliform structures in sauropod skin

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The clade Sauropoda contains the largest known terrestrial animals so far recorded on Earth, with several species potentially exceeding 50 tonnes. Due to the exceptional sizes attained by sauropods, and in many cases convergently, the physiological and biomechanical implications and challenges of sauropod gigantism have become a dominant theme in the scholarship pertaining to these animals. Of these challenges, thermoregulation is one of the most notable. Because of a low body mass to surface area ratio, large-bodied animals possess a high degree of thermal inertia, potentially leading to serious difficulties with heat dissipation. Due to the immense sizes they often expressed, the presence of specialised thermoregulatory adaptations was likely a necessity in sauropods. Here, we explore the role that surficial skin features played in the thermoregulation of sauropods. Preserved sauropod skin is particularly notable in this regard due to the presence of small convex structures, termed “papillae,” across the surface of the scales. While scholarship on the function of these papillae has been limited, we seek to test the hypothesis that they may have facilitated more efficient heat transfer by increasing the relative surface area of the animal. To test this hypothesis a series of digital models were made, representing both papillate and non-papillate scales. These models were subsequently subjected to a variety of heat transfer simulations, varying the number of papillae and the thickness of the scale. A series of multi-way ANOVAs support a heat-transfer mitigation role for the papillae, with a significant relationship found between papillae count and rate of heat transfer. Furthermore, a significant relationship was also found between the effect of the papillae and the thickness of the scale, suggesting they are even more efficient the larger the sauropod. These results provide the first support to the notion that papillae were a size-related adaptation.

A new pelagornithid from the Selandian of New Zealand

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The Pelagornithidae, often referred to as "bony-toothed birds" represent an unusual and extinct family of very large, gliding marine birds. These birds are characterised by unique bony tooth-like projections on their rostrum and mandible, which are distinct from true teeth. Pelagornithids were among the largest volant (flying) birds, with some species reaching wingspans of up to 6.4 metres. Their fossil record spans most of the Cenozoic Era, with remains found on all continents, including Antarctica. Previous work by our research team described *Protodontopteryx ruthae* from the late Danian, Waipara Greensand of Canterbury, New Zealand. This taxon is currently the oldest and smallest known species of bony-toothed bird, and the first pre-Eocene record from the Southern Hemisphere. Here we describe a second larger taxon of pelagornithid from a higher stratum within the Waipara Greensand that we assign to the Selandian. This specimen consists of a partial humerus and a complete tarsometatarsus which we assign to the Paleogene genus *Dasornis*. This new discovery pushes back the temporal record of large, specialized pelagornithids into the immediate aftermath of the Cretaceous–Paleogene extinction event, demonstrating an exceptionally rapid evolutionary trajectory towards gigantism and highly adapted soaring capabilities in the Southern Hemisphere. Its co-occurrence with smaller, more generalized forms from the same locality suggests early and rapid niche partitioning within the Pelagornithidae, reinforcing the critical role of the Zealandia region as a hotspot for post-extinction avian diversification. This fossil provides crucial evidence for understanding the rapid adaptive radiation of volant birds in the early Cenozoic.

§Roll the Rs in Warraty: Innovative human activity inferred from vertebrate faunal remains in northern South Australia (Adnyamathanha Yarta, c. 47–10 ka)

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Australia lost c. 90% of its megafaunal species during the late Pleistocene, an interval marked by climatic fluctuations and the arrival of people c. 60 thousand years (kyr) ago. Archaeological evidence for interactions between people and fauna is limited, especially from the earlier part of the record. This research focuses on the how people in southern semi-arid Australia interacted with faunal species based on an investigation of Warraty rock shelter (Vulkathunha–Gammon Ranges, Adnyamathanha Yarta). Excavated material evidence demonstrates recurrent human activity from c. 47 to 10 kyr ago, contributions from mammalian and avian carnivores, and interactions between people and megafauna. The research aims to resolve: 1) how fire was used in the shelter, apart from cooking; and 2) what human-made modifications are evident on the site's faunal remains, to infer direct and indirect tool use in the Pleistocene. Adnyamathanha traditional knowledge informs hypotheses and interpretations. Infrared spectroscopy is used to examine the molecular structure of bone fragments, allowing a deposit-wide assessment of heating. This method can also be used to assess the impact of time and sediment chemistry on fossil bones. Preliminary results indicate that >50% of burnt bones were burnt without flesh. This may indicate that hearths were rubbish disposals, or bones were used as fuel. Additionally, scrutinising the surface features on bones made it possible to differentiate between the marks made by people (butchery, tool use, hafting), carnivores, and post-depositional weathering. More than 20 bones feature evidence of deliberate modification, and at least five were likely used as tools. The project presents an example of holistic research, and outcomes will inform current understandings of how people participated in the late Pleistocene semi-arid ecosystem of southern Australia.

***§ Morphometric and phylogenetic analysis of enigmatic Russian and Baltic region tetrapod-like fish (“osteolepiforms”) using cranial and endocranial material**

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The osteolepidids are a basal paraphyletic grouping of stem tetrapods (tetrapodomorphs) spanning the Devonian to early Permian of the Palaeozoic era. These lobe-finned fish (sarcopterygians) share many morphological features with tetrapods. One group, the Osteolepididae is made up of four families, the osteolepidids, megalichthyids, canowindrids and the tristichopterids. Both the megalichthyids and canowindrids have a generally stable phylogenetic topology, while osteolepidids and tristichopterids remain less well resolved. Using computed tomography, we generated digital models of the endocranial material of thirteen enigmatic taxa of Osteolepiformes from the Russian and Baltic regions. This has revealed new morphological details for these taxa. We combined morphological data from these thirteen taxa with a larger dataset whereby 23 linear measurements were taken across cranial and endocranial models. This allowed for a multivariate morphometric analysis deepening our current understanding of the endocranial morphological disparity across these taxa. Results from a phylogenetic analysis incorporating these new traits have improved resolution of stem-tetrapod interrelationships. The undocumented endocranial anatomy of the enigmatic Russian/Baltic taxa has provided means for a deeper understanding of the relationships within the Order Osteolepiformes. The methods used in this investigation are applicable not only to the thirteen taxa under study, but to any enigmatic specimens known from cranial elements. Future studies will further investigate the character-rich endocranial elements.

§Breaking the limits: Inclusion of extinct species increases the cranial morphological morphospace occupation of marsupial mammals

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Marsupials are the dominant group of Australian native mammals and have been central to debates on mammalian evolutionary adaptability and morphological diversity. Historically, marsupials were considered less adaptable in their limb and skull (cranial) morphology than placental mammals due to their early birth and limited diversity among living species. However, extinct marsupials exhibit unique cranial morphologies, and much of Australia's megafauna comprised large Vombatiformes (koalas and wombats) and Sthenurinae (short-faced kangaroos), characterised by distinctive cranial shapes. Together with their living relatives, they may contribute to a broader marsupial morphospace than previously recognised. We used 3D-geometric morphometrics on cranial landmarks from 95 marsupial species across eight orders: 70 extant and 25 extinct (16 diprotodontians). Using all Principal Components Analysis scores, we then compared multidimensional morphospace occupation (morphospace volume, density, and position) through the functionalities of the DispRity package. Morphospace size (the sum of squared distances from the sample Procrustes mean) differed significantly between extant and extinct marsupials, with extinct species having a larger volume than extant marsupials. Not unexpectedly for our comparatively small sample, density was higher in extant compared to extinct marsupials as their species clustered more closely, but both groups occupied significantly different positions in morphospace. The sample was moderately allometric, but not very meaningful across the three orders of size magnitude represented in the sample. Our results show that extinct marsupials occupy a larger cranial morphospace than extant marsupials, with forms more distinct and widely distributed from the main marsupial cluster. This suggests that including extinct marsupials expands marsupial cranial diversity by adding extreme and unusual cranial morphologies, rather than increasing the density of similar cranial shapes. These findings highlight the importance of fossils in morphometric studies and warrant further comparative research with similar samples of placentals.

§Shape analysis of scincid fossils from the Pleistocene of Wellington Caves, NSW, Australia

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The Pleistocene–Holocene fossil deposit of Cathedral Cave (Wellington, NSW) spans ~70 kyr during periods of great change in Australia's climate and environments. Among the preserved faunal component are scincids, which account for ~40% of Australian Squamata and play integral roles in numerous Australian ecosystems. The ecological importance of scincids makes them important subjects for understanding past environments, however they remain relatively understudied within the Australian fossil record. Previous scincid research has primarily concerned specimens with substantial morphological distinctions, while taxa with more nuanced diagnostic features often have lower accuracy in identifications when using conventional qualitative comparative techniques. Geometric morphometrics (GMM) has shown success in the identification of non-scincid squamate fossils, making it a strong candidate to improve existing identification methods for scincids. We here evaluate the capability of GMM to support the identification of scincid fossil material, and to identify material to the lowest taxonomic level possible. We analysed 46 fossil scincid dentaries from Cathedral Cave in comparison to 32 species living in the area and previously identified from the deposit, or genetically related substitutes. We generated 3D-models of each specimen from micro-Ct scan data, with a total of 31 fixed landmarks and 33 curves used to capture shape information. Principal Component Analysis indicated high levels of shape variation in areas that have been previously used to identify scincids, and Procrustes ANOVAs revealed groupings consistent with tribe and genus level differentiation. While species level distinctions are not supported for all specimens, tribe and genus level relationships are reflected in the data. To support these identifications to a higher degree, a larger comparative sample and accessibility to modern scans are required. This study

shows that GMM has promise as another tool in the identification of fossil material and provides a clearer understanding of scincid diversity of late Pleistocene Australia.

Where does Neds Gully stand in the Australian megafauna extinction debate? Latest findings from a critical Late Pleistocene site

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An influential paper by Roberts et al. (2001, *Science*) reported new ages for Late Pleistocene megafaunal fossil deposits across Australia. Based largely on two sites at opposite ends of the continent—Neds Gully in southeast Queensland and Kudjal Yolgah Cave in southwestern Australia—they argued for the synchronous extinction of all Australian megafauna at ~46 ka. That interpretation has since been criticised as a significant oversimplification of extinction dynamics, particularly given that the sites are separated by more than 3,500 km and that few intermediate deposits were available for comparison at the time. Here we present the latest data from Neds Gully, a small tributary of the Condamine River, which forms part of upper the Murray-Darling Basin, Australia's largest fluvial drainage system. Over the past few decades of fieldwork, we have collected fossils and integrated them into a stratigraphic framework. The assemblage is taxonomically diverse, including classic megafauna, small-bodied vertebrates, and invertebrates. Dating shows that articulated remains of *Diprotodon optatum*, the largest marsupial that ever lived, occurred at least from >60 ka through to ~41 ka, indicating that the megafaunal component is not restricted to a single age. By contrast, smaller vertebrates are dated to as young as ~30 ka, while freshwater tufas and invertebrate faunas extend into the Holocene. These findings highlight the complex temporal and palaeoecological record preserved at Neds Gully. Rather than supporting a simple extinction pulse at ~46 ka, the site reveals staggered survival of different taxa and palaeoenvironmental shifts over tens of millennia. Neds Gully therefore provides one of the richest and most nuanced palaeochannel archives of late Quaternary extinction and environmental change in Australia.

§A new Plio-Pleistocene fossil water-rat (*Hydromys*) from Barrow Island, Western Australia

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One of Australia's most iconic rodents, the Rakali or Water-rat (*Hydromys chrysogaster*), is part of the amphibious *Hydromys* Division of rodents. The group's centre of diversity is based in New Guinea, where they first evolved before reaching Australia. Genomic research places the arrival of *Hydromys* in Australia in the mid-Pleistocene, about half a million years ago. However, compared to other rodent groups, the *Hydromys* Division has a poor fossil record, limiting the availability of fossil evidence to provide calibration points for such studies. This research presents a new Plio-Pleistocene fossil species of '*Hydromys*' from Barrow Island, off the northwest coast of Australia. Known from a single specimen, a left first lower molar (Lm₁), this preliminary description represents the first fossil relative described from this widespread group. To attempt to place this fossil within the *Hydromys* Division phylogeny, the Lm₁ length and width of five Australian and New Guinean species were measured on modern and fossil specimens in the Australian Museum and Western Australian Museum. The morphology of the tooth was also described and compared to that of its closest living relatives. The fossil species is smaller than the modern *H. chrysogaster* and New Guinean *Parahydromys asper*, but larger than other New Guinean *Hydromys* Division species measured (*H. hussoni*, *Baiyankamys shawmayeri*, and *Crossomys moncktoni*). Future, more precise, dating of the source site to better understand the age of this fossil could redefine our understanding of the arrival of the *Hydromys* Division in Australia.

*§ Evaluating the discrimination power of cranial bone shape for clades of New Zealand skinks

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Cranial bones have successfully been used to discriminate reptile species in the fossil record. In New Zealand skinks (*Oligosoma* spp.), it has long been thought that species could only be distinguished, using cranial and postcranial bone size, into ‘large’ and ‘small’ skinks, despite the skink’s molecular phylogeny consisting of eight clades potentially consistent with different genera. However, the utility and discriminatory power of cranial bones in distinguishing among major clades of *Oligosoma* has not yet been evaluated using modern approaches compared to previous conventional morphological techniques. To test whether there is taxonomically informative shape variation in extant species of *Oligosoma*, we applied a 3D-geometric morphometrics approach to characterise the shape of five key cranial bones (frontal, parietal, quadrate, maxilla, and dentary). We found the dentary and frontal were the most informative bones for clade-level discrimination, followed by the parietal and maxilla, while the quadrate was the most conserved. Based on principal component analysis, canonical variate analysis, and Mahalanobis distances, the dentary can distinguish clade 4 from other clades, while the frontal distinguishes clade 1 from clades 2, 4, and 5. The parietal helps to differentiate clade 4 from clades 1 and 2, and clade 1 from clade 2. Taken together, the dentary, frontal, parietal, and maxilla allowed us to distinguish clades 1, 2, 4 and 5 of *Oligosoma*. Including skinks from clade 3 and additional specimens from clades 6 to 8 in future analyses may allow us to differentiate these groups. Our preliminary findings suggest that cranial bone shape may be useful for assigning subfossil specimens to their respective clades. Incorporating non-destructive palaeogenetic analyses of these subfossil specimens will enhance our understanding of New Zealand's past herpetofaunal diversity. Geometric morphometrics shows promise as a more precise method of quantifying shape and size differences, especially in groups thought to be morphologically conservative.

Comparative anatomy of the gluteal muscles in marsupials: Resolving homology and nomenclature

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The gluteal muscle group is critical to mammalian locomotion, contributing to hip extension for forward propulsion, as well as more precise movements such as abduction and rotation of the thigh. Despite its functional importance, marsupial gluteal anatomy remains poorly documented and inconsistently named. Applying placental nomenclature, especially terms derived from humans and domestic animals, often misrepresents marsupial muscle identity. Many existing descriptions are based on limited sample sizes, narrow taxonomic coverage, and insufficient anatomical detail, making cross-species comparisons from the literature alone unreliable. This study synthesises nearly a decade of dissections across major Australian marsupial lineages to clarify gluteal muscle identity, homology, and nomenclature. Specimens from 12 of the 16 extant Australian families were dissected, with muscles identified by innervation and compared to the established gluteal anatomy in placental mammals. Dissections revealed substantial variation in muscle architecture and attachment, particularly in *m. gluteus minimus* and *m. gluteofemoralis*, with macropodoids showing the most divergent forms likely due to their specialised bipedal hopping gait. Here, we propose a revised nomenclature grounded in innervation patterns and consistent dissections by a single observer. These findings highlight the importance of resolving muscle anatomy when interpreting fossil bones and offer a clearer framework for understanding marsupial muscle homologies to provide a foundation for future research in functional morphology, locomotion and biomechanics, and evolutionary biology.

***§ Deciphering *Cainocara enigma* from the Late Devonian Gogo Formation, Australia**

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The Late Devonian (Frasnian) Gogo Formation in Western Australia contains a wide diversity of early vertebrates, with exceptional three-dimensional preservation. These include specimens of placoderms (antiarchs, arthrodires, ptycodontids), chondrichthyans (acanthodians and stem-chondrichthyans), sarcopterygians (dipnoans, coelacanth, onychodontids, tetrapodomorphans), and actinopterygians. Historically placed outside of these groups is a single enigmatic specimen *Cainocara enigma* (ANU46542), a highly eroded and poorly preserved osteichthyan partial braincase and mandible. In its initial description, due to its highly unusual morphology, it was considered to represent some otherwise unknown order. We herein reanalyse and redescribe it, with the aim to identify the phylogenetic affinity using modern digitisation techniques and morphometric analysis. Using computed tomography (CT) and digital segmentation, we reconstructed models of the cranium and internal space of the braincase (the ‘endocast’). This allowed us to properly orientate the specimen, revealing key features to identify its phylogenetic affinity. We determined that *C. enigma* was initially interpreted as upside-down and back-to-front, with the ‘dorsal plate’ instead being a lozenge-shaped parasphenoid stalk. We also discovered well preserved palatal bones hidden behind layers of eroded bone, and well-preserved canals for the inner ears and hindbrain cavity in the endocast. A Principal Component Analysis using linear measurements, compared with a dataset of other Gogo endocasts, showed that the endocast of *C. enigma* shares a similar morphospace to other Gogo lungfish (especially *Holodipterus*) but still occupies a unique morphological niche. We believe that *Cainocara enigma* is a taphonomically modified lungfish, but without more substantive analysis, either phylogenetic or morphometric, it will remain a nomen dubium. However, this study highlights the value in revisiting old specimens with a new perspective and modern techniques to better understand that which had been previously unresolved.

The subfossil fauna of Goat Cave and Prostate Pit Cave, Mundrabilla Station, Nullarbor Plain, Western Australia

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The Nullarbor Plain contains a vast karst system, with thousands of caves preserving remains of the original fauna before European modification of the Australian landscape and biota. The Nullarbor region records the highest rate of mammal extinction in Australia. We report the results of cave floor surface collections from Goat and Prostate Pit Caves. Goat Cave preserved 25 mammal, 6 bird, 5 reptile and 3 snail taxa and had incredibly well-preserved, fully-furred, mummified brushtail possums (*Trichosurus vulpecula*) and a chuditch (*Dasyurus geoffroii*). Prostate Pit Cave preserved 20 mammal, 1 bird, 7 reptile and 4 snail taxa. Remains in Goat Cave were predominantly accumulated by masked owls, while remains in Prostate Pit Cave were accumulated mainly by dingoes and pitfall trapping. We also report cave use by brushtail possums and dingoes, and a collection, transport, and preservation methodology for fragile, furred, mummified mammals.

New fossil koala (Marsupialia: Phascolarctidae) from the Pleistocene of Western Australia

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Fossils of koalas have been known from Western Australia since 1910 but are today regionally extinct. Jaws and bones were previously reported from several cave deposits in the southwest of WA, Koala Cave in Yanchep, and from Madura Cave on the Roe Plain. Due to the similarity of the dentition with the east coast koalas (*Phascolarctos cinereus*), they were traditionally assumed to be the same species. Two complete additional adult skulls were collected in the past 25 years, from caves near Augusta on the southwest coast. These skulls are interpreted to belong to a male and female koala, are similar in body size to koalas from Victoria, but the shape of the skulls differ significantly, in being relatively much shorter in length, and having obvious deep concavities on the maxilla, below the zygomatic arch. Differences from the eastern species are also apparent in the postcranial skeleton. For example, the head of the femur is relatively smaller, and the heads of the metacarpals are relatively narrower in comparison to similar-sized individuals from Victoria. Analysis of measurements on the skulls and teeth show that the Western Australian koala is morphologically distinct from its east coast relative and warrants consideration as its own species. The fate of the new species is already known. It likely went extinct in WA as a result of climate change during the late Pleistocene which reduced eucalyptus forests to around 5% of their current cover, reducing resources for food and shelter.

The feeding behaviour of a large apex predatory arthrodiros *Dunkleosteus* from the Late Devonian (Famennian) Cleveland Shale, Ohio

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Dunkleosteus terrelli has long been recognized as an apex predator, and although there is doubt as to its actual size it was one of the largest placoderms to have existed. Fossil remains are best known from the Cleveland Shale, Ohio, USA. The dermal plates are mostly preserved flattened, and the skeletal cartilages are rarely preserved necessitating considerable interpretation to reconstruct the anatomy. The robust shearing jaws in addition to associated shark teeth and boluses comprising partly digested fish indicate a predatory ecology. Previous studies suggested *Dunkleosteus* was capable of suction feeding. Newly discovered ossified areas of the palatoquadrate and soft tissues in closely related taxa from Western Australia raise questions regarding the validity of previous reconstruction of musculoskeletal anatomy in *D. terrelli* and interpretations of suction feeding. Using this new morphological information, we re-investigate the musculoskeletal anatomy of *Dunkleosteus terrelli* with the aim of elucidating the functional morphology of the feeding apparatus. The preservation of the palatoquadrate and hyomandibular in *Eastmanosteus* approximates grooves on the cheek plates of *D. terrelli* suggesting that both taxa had a similar morphology. Unlike previous reconstructions in which the m. adductor mandibulae is depicted as having its origin on the skull roof, the origin was on the palatoquadrate and insertion on the adductor fossa of the inferognathal extending onto the Meckel's cartilage. The suborbital plate shows a large suborbital channel at the anterior edge of the suborbital that indicated the path of a large m. preorbitalis which in extant taxa is a key muscle in jaw closure. The jaw articulation is autostylic and there is no evidence for a protrusible jaw. The large gape, posterior articulation of the jaws and blade-like teeth on robust infragnathals all argue against suction feeding being more consistent with ram feeding.

§Revisiting *Lapillopsis nana* from the Triassic Arcadia Formation of Central Queensland, Australia

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A tiny endemic fossil amphibian, *Lapillopsis nana*, from the Triassic Arcadia Formation (Rewan Group, Bowen Basin) was described from complete crania and some postcrania in 1990 as a dissorophoid temnospondyl, like *Micropholis stowi*. Now accepted as a basal stereospondyl, this miniaturised tetrapod poses a challenge for taxonomists. Several additional specimens have since been referred to *L. nana*, and more recently others into a family of its namesake, Lapillopsidae. While monophyly is sometimes supported, the more recent material is less complete, and often recovered in clade or basal polytomy with lydekkerinid stereospondyls. Most material being cranial, fragmentary, or obscured by rock matrix, directly examinable material provides low character coverage for this taxon in recent phylogenetic datasets. With the retention of some basal traits in this Triassic-age macrofaunal stereospondyl, *L. nana* tends to destabilise phylogenetic outputs, creating uncertainty regarding its affinities. Our project reviews the type material held in the Queensland Museum collections and tests the validity of referred and related material. Using Australian Synchrotron CT scans segmented by James Cook University's internally developed Deep Learning model, features obscured by ironstone matrix can now be assessed. Findings indicate that some referred specimens differ distinctly from type material, and as Lapillopsidae was initially erected based on this referred material we propose amendment of the clade, diagnostic criteria and nomenclature. Furthermore, during digital curation and photography of type and referred material, unpublished postcranial holotype material was discovered. New data from CT scans and the recently discovered postcranium for *L. nana* and other lapillopsids are incorporated into a refined character data matrix and analysed using TNT. This work indicates higher macrofaunal amphibian diversity in the Arcadia Formation than previously appreciated and illustrates the value of revisiting historic collections where new methodologies such as synchrotron CT-imaging can reveal previously unknown data.

*§ Severed Ties: A 'Gap' in the connectivity of late Quaternary rainforests along Australia's eastern margin

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Australia's ecosystems have been shaped by a complex climatic history involving progressive aridification and gradual retreat of once widely distributed rainforests to the eastern margin of the continent. Subsequent habitat fragmentation has resulted in a patchy distribution of such ecosystems that are today separated by dry biogeographic corridors. Previous studies, based on similarities between fossil faunas recovered from central eastern Queensland (Mt Etna) with fossil and extant faunas from New Guinea, suggested a rainforest connection between these regions that was broken sometime in the late Quaternary (~280–205 ka). During this period, rainforest-adapted species at Mt Etna were replaced by arid-adapted species. Analysis of well-dated fossil deposits from the Broken River region in northeastern Queensland—a region within the northeastern biogeographic corridor, the Burdekin Gap—reveals that the local environment in the region has remained relatively stable for the last ~350 ka. No rainforest specialist taxa were found in the deposits and the faunas were dominated by open, xeric-adapted taxa throughout. These results suggest that the eastern margin of Australia was not a continuous strip of rainforest at 280 ka, and that any rainforest connectivity between central eastern Queensland and New Guinea was severed sometime before 350 ka. Furthermore, while we found evidence of extinctions over time, these are not clustered at any specific point, nor do they appear to be closely linked to periods of substantial habitat loss. Our findings align genetic studies on the molecular-divergence timings of mammalian species on either side of the Burdekin Gap, suggestive of an older breakup timing of northeastern rainforests. Our results highlight the complexity of faunal responses to changing environmental changes and underscore the challenges we face in conserving our at-risk extant faunas.

§A review of the diprotodontid marsupials of New Guinea and their locomotory adaptations

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The evolutionary history of marsupials in New Guinea is poorly understood. For the Diprotodontidae, a family of late Cenozoic megaherbivores best known from Australia, prior taxonomic studies of New Guinean forms have been hampered by a lack of material, most of which was collected between 1930 and 1990. Here, we report on newly collected specimens from the Pliocene Otibanda Formation, Morobe Province, Papua New Guinea, which facilitate taxonomic reassessment of some species. We reallocate *Kolopsis rotundus* to the genus *Maokopia* because it shares greater similarities with the Pleistocene *Ma. ronaldi* than it does with the type species, *K. torus*, from the Miocene of central Australia. We recognise the first fossil vertebrate described from New Guinea, *Nototherium watutense*, as a *nomen dubium*. Functionally, the limbs of *Ma. rotunda*, *Ma. ronaldi* and *Hulitherium tomasettii* share similarities with those of Pliocene–Pleistocene diprotodontids *Zygomaturus trilobus*, *Diprotodon optatum* and *Ambulator keanei* from mainland Australia, which suggests that these species were graviportal. In contrast, partial humeri from the Otibanda Formation here ascribed to *Kolopsoides cultridens* lack these graviportal adaptations, and more closely resemble those of late Miocene, ground-dwelling diprotodontids from Australia. The presence of both graviportal and non-graviportal morphotypes in the Pliocene of New Guinea suggests two separate colonisation events of New Guinea by diprotodontids from mainland Australia.

* *Kryoryctes cadburyi* is a Monotreme, for sure, maybe

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When *Kryoryctes cadburyi* Pridmore et al., 2005 was first named and described, the title of the article included the phrase “...Tachyglossid-like...”. Given that the holotype humerus was on the order of 100 million years older than any undoubted tachyglossid fossil, this prudence was quite warranted in its own right. The authors had carried out a detailed morphological analysis of the holotype and concluded *K. cadburyi* was highly likely to be a monotreme. But they did note that there were features of the elbow joint not found in monotremes but instead were characteristic of all therians examined. Subsequently, Hand et al. 2025, in a study focused primarily on the lifestyle of *K. cadburyi*, made further morphological analyses of the holotype and, likewise, concluded that the fossil was that of a monotreme. Supporting this conclusion was a parsimony analysis of 536 characters of the entire mammalian skeleton carried out by Robin Beck. At the request of the authors of this abstract, Robin Beck performed a similar parsimony analysis based on only those 19 characters available on the holotype of *K. cadburyi*. Using only those characters available on the holotype, *K. cadburyi* was closer to all therians in the data set than to the monotremes. It would seem that the parsimony analysis that is based on the entire mammalian skeleton is sensitive to the total morphology of the holotype. In contrast, the parsimony analysis based on only those characters that are actually present on the holotype of *Kryoryctes cadburyi*, 3.5% of the 536, is more sensitive to characters in the elbow joint. Were Rosendo Pascual still with us, he might well have echoed part of the title of this abstract – “*For Sure, Maybe!*”.

Sexual dimorphism and allometric patterns in the craniodental morphology of dasyurid marsupials

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Sexual dimorphism refers to phenotypic differences between males and females within a species that arise as a result of sexual selection. Sexual size dimorphism (SSD), for example, is commonly observed in mammals and is often associated with male competition, as documented in species such as kangaroos and great apes. Rensch's rule outlines a trend in which SSD increases with body size, especially in males, affecting characteristics such as cranial and skeletal morphology. In palaeontological studies, sexual dimorphism is frequently used to explain aspects of intraspecific variation and may even be used to infer the sex of individual specimens of extinct species. This study investigates patterns of SSD, allometric relationships following Rensch's rule, and the potential for cranial measurements to predict sex across 17 dasyurid species with diverse body sizes and diets, ranging from insectivory to hypercarnivory. We found that SSD varies widely among dasyurids, with larger species generally more dimorphic, consistent with Rensch's rule. Most variables showed male-biased SSD, especially in larger species (female body mass >100g), with differences often exceeding 25% and, in some cases, males being twice as large as females. The Tasmanian devil is a notable exception, showing no significant SSD and acting as an outlier in allometric patterns and phylogenetic analyses. Smaller species exhibited less consistent SSD, though certain variables like upper canine height were notably dimorphic in some small species. MANOVA analyses indicated significant sex discrimination based on cranial measurements in most species. However, the specific variables contributing to sex discrimination varied widely among species. This study highlights the complex nature of sexual dimorphism in cranial morphology and the associated challenges of utilising craniometric data for sex determination across species. It underscores the necessity for robust data when drawing conclusions about sexual dimorphism in extinct species.

* A new meiolaniid turtle from mid-Oligocene deposits of Riversleigh, northwestern Queensland, Australia

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Meiolaniid turtles are an enigmatic group of fossil turtles whose remains have only been found in Argentina, Australasia and New Zealand. The group is sometimes referred to as "horned turtles" because many species within this family have horn-like cranial projections at the back of the skull. The horns, like other cranial protuberances, develop from growth centres on three cranial scutes (labelled A, B and C). The genus *Meiolania* is defined by the presence of cow-like horns on the B scute; other meiolaniid turtles have various shaped protuberances on the three cranial scutes, but not cow-like in form. The Riversleigh World Heritage Area, in northwestern Queensland, Australia contains several local fossil faunas that include meiolaniid turtles. To date, only one of these has been formally described (*Warkalania carinaminor*) from a mid-Miocene site. Recently, various, isolated bones from meiolaniid turtles were recovered from a late Oligocene site at Riversleigh. The most useful bone elements recovered were two squamosal bones, one from an adult and another from a presumed sub-adult meiolaniid turtle. These turtles lacked cow-like horns but had a crown of smaller domes and prongs, and a frill around the rear of the skull. This arrangement is unique amongst meiolaniid turtles and represents a new genus and species. The sub-adult squamosal has several differences in the conformation and orientation of the cranial protuberances compared to the adult squamosal. Comparisons were made with sub-adult squamosal material from the Pleistocene meiolaniid, *Meiolania platyceps*, to enable an assessment of the changes in cranial shape and ornamentation during late-stage growth and development in meiolaniid turtles.

§ Hei honoa mai: Multidisciplinary collaborations with collagen peptide mass fingerprinting (ZooMS) and identifying marine mammal species utilised by iwi Māori

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Recent developments in palaeoproteomics, particularly Zooarchaeology by Mass Spectrometry (ZooMS), are opening new pathways for palaeontological and archaeological research in Aotearoa New Zealand. ZooMS offers accessible, cost-effective, and minimally invasive methods for identifying species from bone and other collagenous materials. However, its application across Australasia and the Pacific has been limited by the need for comparative reference data and local species spectra. Here, we present an overview of the *Ika Moana Ika Whenua* project, building a large southern South Pacific marine mammal reference dataset, developing novel peptide markers, and a case example of indigenous-led research design and collaboration, expanding the relevance of these methods for local contexts. Taxonomic identification of marine mammal species from bone is challenging, especially as morphologically unidentifiable fragments are common within assemblages. By adapting minimally invasive ZooMS techniques within a kaupapa Māori framework, this project centres Indigenous values in both research practice and outcomes. Aligning community aspirations with elements of environmental and biomolecular science, *Ika Moana Ika Whenua* supports iwi Māori in restoring relationships with marine mammal species, prioritising relational knowledge, and nurturing culturally attuned and community accessible approaches to research.

* Dental growth in the tyrannosaurid *Gorgosaurus libratus*, with implications for ontogenetic niche shifting in large-bodied carnivorous dinosaurs

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Ontogenetic niche shifting is a life-history adaptation whereby individuals undergo significant growth-related transitions in their ecological role. This phenomenon mitigates predation risk and juvenile mortality and decreases intraspecific competition for resources. Species exhibiting growth-dependent niche shifts typically display distinct morphological and behavioural variations between juveniles and adults, including substantial increases in body size and dental shape alterations, often characterized by increased heterodonty. While ontogenetic niche shifting has been hypothesized in carnivorous dinosaurs, particularly when considering macro-scale community body size distributions, few studies have explored intraspecific (growth-related) patterns, and ontogenetic changes in tooth morphology remain poorly understood. Here, we present the first application of dental topographic analyses to quantify variations in tooth shape and heterodonty throughout a growth series of the tyrannosaurid *Gorgosaurus libratus*. Dirichlet normal energy (DNE), orientation patch count rotated (OPCr), relief index (RFI), crown slope index (CSI), and crown-base ratio (CBR) values were calculated for 13 tooth-bearing elements of specimens of various ontogenetic stages, with toothrow lengths from 166 to 445 mm. Morphological disparity of these metrics along the tooth row served as a proxy for heterodonty. All were evaluated against toothrow length, a proxy for relative ontogenetic stage. Our findings indicate no significant size-dependent relationships in DNE, OPCr, or RFI values, with two of these metrics varying in the extant *Varanus komodoensis*, a known ontogenetic niche shifter. However, CSI and CBR values vary significantly with size, supporting a functional shift from purely slicing in juveniles to bifunctional teeth capable of slicing and crushing in adults. While these results support changes in dental shape across the growth of *G. libratus*, they do not necessarily support an ecological shift, challenging the hypothesis of ontogenetic niche shifting in large-bodied carnivorous dinosaurs. This study highlights the need for a more nuanced exploration and definition of ontogenetic niche shifting, particularly when considering extinct taxa.

Bone microstructure supports a Mesozoic origin for an amphibious lifestyle in monotremes (Mammalia)

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The platypus and four species of echidna are the only living egg-laying mammals and are the sole extant representatives of the order Monotremata. The platypus and echidnas are very disparate both morphologically and ecologically: the platypus is a specialised semi-aquatic burrower that forages for freshwater invertebrates, whereas echidnas are fully terrestrial and adapted for feeding on social insects and earthworms. It has been proposed that echidnas evolved from a semi-aquatic, platypus-like ancestor, but fossil evidence for such a profound evolutionary transformation has been lacking, and this hypothesis remains controversial. Here we present new data about the Early Cretaceous (108–103 Ma) Australian mammal *Kryoryctes cadburyi*, currently only known from a single humerus, that provides key information relating to this question. Phylogenetic analysis of a 536-character morphological matrix of mammaliaforms places *Kryoryctes* as a stem-monotreme. Three-dimensional bone comparisons show that the overall shape of the humerus is more similar to that of echidnas than the platypus, but analysis of microstructure reveals specialisations found in semi-aquatic mammals, including a particularly thick cortex and a highly reduced medullary cavity, features present in the platypus but absent in echidnas. The evidence suggests *Kryoryctes* was a semi-aquatic burrower, indicating that monotremes first evolved an amphibious lifestyle in the Mesozoic, and providing support for the hypothesis that this is ancestral for all living monotremes. The lineage leading to the modern platypus appears to have been characterised by extremely long term (>100 My) niche conservatism, with echidnas representing a much later reversion to a fully terrestrial lifestyle.

* The oldest known backbone?

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A tiny 400-million-year-old fossil braincase from western Queensland proves to belong to the enigmatic *Palaeospondylus* (Greek for ‘ancient vertebra’), the oldest example from the fossil record to show a segmented vertebral column (‘backbone’). *Palaeospondylus* has attracted numerous competing interpretations since it was first described 135 years ago from a single flagstone quarry, Achannaras, in Scotland. This has produced thousands of articulated specimens. The skeletal tissue of *Palaeospondylus* has a distinctive histology of large cartilage cells spaces. Our unique, uncrushed 3D-preserved braincase, CT-scanned at ANU (Dept. Materials Physics, RSPHys), provides the first details of brain cavity and inner ear structure, position of cranial nerves, blood vessels, etc. (Burrow, Young & Lu 2025, *National Science Review*, <https://doi.10.1093/nsr/nwae444>). The structure of the labyrinth cavity (inner ear) is highly unusual. Cranial morphology of the new Australian species *Palaeospondylus australis* demonstrates that a controversial recent claim (published in *Nature* 2022), that *Palaeospondylus* has tetrapod affinity (i.e. closely related to land vertebrates), relies on erroneous braincase interpretations. Our phylogenetic analysis suggests *Palaeospondylus* may be a stem gnathostome, or possibly a sister group to Chondrichthyes.

§Imaging and redescription of *Prognathodon waiparaensis* from the Waipara River of New Zealand

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Mosasaur were a group of secondarily aquatic reptiles that were one of the major vertebrate predators of the Late Cretaceous seas. New Zealand's diverse mosasaur assemblage includes several species. One of these, *Prognathodon waiparaensis* Welles and Gregg, 1971, is known only from the holotype, CM Zfr 108, recovered from the Waipara River of North Canterbury, New Zealand. While this has been previously described in Welles and Gregg's 1971 monograph, a redescription of CM Zfr 108 allows comparisons with material unearthed in the more than 50 years following this work. It also allows for a reassessment of its phylogenetic position, which has been questioned by many recent works. In addition to redescribing CM Zfr 108, 3D-surface-scans were taken to digitise the material to allow for easier sharing of data for future work. The redescription has resulted in minor updates to the 1971 work of Welles and Gregg and has allowed comparisons with other recently described species of *Prognathodon*, as well as other mosasaur taxa. Although it was a cosmopolitan genus during the Campanian–Maastrichtian, *P. waiparaensis* shows affinities with other Gondwanan *Prognathodon* species. While conforming to a similarly robust cranial morphology as other members of *Prognathodon*, *P. waiparaensis* differs in its tooth shape and wear patterns, suggesting different prey preferences to species of *Prognathodon* from the Northern Hemisphere.

A Pleistocene vertebrate fossil locality informing palaeoenvironment and ecology in an unflooded Naarm (Port Phillip)

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This paper reports a hitherto undocumented, diverse vertebrate fossil deposit occurring near Werribee, Victoria. Sixteen extinct and extant taxa have been identified to date: *Palorchestes azael*; *Palorchestes* cf. *parvus*; *Diprotodon optatum*; *Macropus giganteus*; *Macropus titan*; *Notamacropus rufogriseus*; *Protemnodon anak*; *Protemnodon* cf. *mamkurra*; *Procoptodon rapha*; *Sthenurus andersoni*; *Simosthenurus* sp.; *Lasiorhinus krefftii*; *Vombatus ursinus*; *Thylacoleo carnifex*; *Sarcophilus lanarius* and Aves cf. Megapodiidae. Fossils occur ex situ but enclosing grey-beige bioturbated siltstone matrix corresponds with the locally eroding Pleistocene Deutgam Silt, which comprises alluvial sediments of the formerly unconfined Werribee River fan. Preliminary interpretation suggests fossil deposition in the Werribee palaeochannel under oxygenated, low-energy fluvial conditions e.g. a floodplain overbank or delta, with little diagenesis. Biostratigraphic processes influencing survivorship and preservation are discussed, with reference to regional biogeography. This locality is suggested to preserve a distinct ecosystem for an unflooded Naarm (Port Phillip) during a Late Pleistocene glacial interval(s). The new fauna is compared briefly to proximal fossil localities and considered in relation to faunal dispersal across the emergent Bassian land-bridge. It has significant implications for reconstructing Kulin landscapes prior to or coincident with First Peoples' presence in south-eastern Australia. Consultation with Traditional Owners and present land managers is outlined, and avenues for further research presented.