



OPUNTIA 547



**Opuntia** is published by Dale Speirs, Calgary, Alberta. It is posted on [www.efanzines.com](http://www.efanzines.com) and [www.fanac.org](http://www.fanac.org). My e-mail address is: [opuntia57@hotmail.com](mailto:opuntia57@hotmail.com) When sending me an emailed letter of comment, please include your name and town in the message.

**AROUND COWTOWN**  
photos by Dale Speirs

**Libraries.**

The New Central Library separates the downtown core from the East Village. The cover photo was taken on the east side of the library. The photo below looks in the opposite direction.

I use the NCL frequently. In early April I walked in and was surprised to find a display about Nicolaus Copernicus, evidently provided by the local Polish community.





I had occasion to visit the South Calgary branch of the library on 14 Street SW and 32 Avenue. The building was built into a slope, with the roof serving as part of the adjacent park.







## Murals.

At left: The rooftop of the South Calgary library has its utilities screened by this mural.

Below: As I walked down the 100 block of 9 Avenue SW in the downtown core, I happened to glance into a back alley and was surprised to see this mural. Pretty enough, although the effect was muted by the dumpsters.





At left: Seen in the Beltline district at the 1400 block of 16 Avenue SW.

Bottom: Macleod Trail at 12 Avenue SE across from the Stampede rodeo grounds. The road is the main drag into the downtown core from the south, so I had to wait a while to take the photo until there was a gap in the traffic.





**Accidentally Seen.**

Right: Seen in the Ranchlands district in northwest Calgary.

Below: A high-centred car at the Lakeview Shopping Plaza in southwest Calgary.





At first glance this appeared to be a rust bucket car, but the rust is a painted image, not real. The lizard means something to somebody, I'm sure. Seen downtown in January and never since.





# THE ICE WHEN IT CAME BY

by Dale Speirs

THE ICE AGE IN WESTERN CANADA (2021) by C.W. Gross covers the last 2.6 million years of the provinces of British Columbia, Alberta, and Saskatchewan. Cory Gross, the author, is a freelance geologist and historian here in Calgary. He is the president of the Alberta Palaeontological Society, headquartered at Mount Royal University in southwest Calgary. I am a member of the APS.

The topography everywhere in the western provinces was shaped by ice and water. There are no ancient landscapes in Alberta, for no part of the surface geography is older than about 5,000 years. The bedrock is hundreds of megayears old, but the rivers, hills, lakes, and soils only developed as the ice melted.

Before beginning with western Canada, Gross briefly covered previous ice ages. 2.4 to 2.1 gigayears ago, Snowball Earth occurred because photosynthetic microbes converted the atmosphere from methane to oxygen.

The Great Oxygenation Event, as it is known, dropped temperatures and froze most of Earth's surface, the first ice age. Several more ice ages followed at intervals. The most recent one, which shaped hominid evolution, was the Pleistocene.

Ice ages are triggered by a combination of plate tectonics and a set of astronomical cycles called the Milankovich Cycle. By themselves, they do not trigger ice ages but when aligned together at intervals the combination cools off the planet.

And so to Canada. There were two continental ice sheets, the Laurentide over the Arctic and eastern Canada, and the Cordilleran, over Alberta, British Columbia, and Yukon. The Rocky Mountains were originally green, rounded mountains like the Appalachians.

When the ice ages ended, the meltwaters eroded the Rockies into the jagged peaks they are today. Out on the prairies, giant valleys were carved which now only have a trickle of water flowing through them. The Bow River valley, where downtown Calgary sits, still has a large river but its bottomlands are many times wider.

There was never one single ice age during the Pleistocene. The ice sheets and mountain glaciers expanded and retreated from 20 to 50 times, although the ice didn't completely vanish. The spread or retreat of ice varied locally depending on geographical or meteorological conditions.

The strata laid down during all these ebbs and flows of ice showed the different faunas and floras. Mammoths and saber-tooths were to be expected, but common Alberta fossils of the Pleistocene are camels, lions, and cheetahs. They lived during the warmer interglacials, then were driven back each time the ice expanded.

Camels and lions were distributed across the Northern Hemisphere but eventually were extirpated except for relict populations that descended into Africa and Arabia. There were many marvelous species during episodes of global warming. Megafauna were common, such as mammoths and longhorn bison.

During maximum ice, sea levels fell, exposing land that is today underwater. The coastal islands of British Columbia were once hills on plains that went underwater at the end of the ice sheets. Early humans migrating along the Pacific coast lived on those plains. Melting forced their distant descendants back up the slopes of the coastal mountains.

The marine life changed as glaciers pushed in and pulled out of the coastal waters. Baleen whales and sharks were dying out long before humans arrived. Dolphins became successful, including orcas, which are not, as they are commonly called, killer whales. Killer, yes, whales, no.

Running north-northwest to south-southeast in the southern half of Alberta is a chain of giant boulders known as glacial erratics. They follow the line of the Last Glacial Maximum where the Cordilleran and Laurentide ice sheets collided with each other.

The giant boulders were scraped off mountain sides in the Rockies, then carried along on the surfaces of glaciers. Their origin was determined by comparing their mineral content with mountain strata. Many of the erratics are the size of a sedan car.



One of them is known as Okotoks (from the Blackfoot language for “big rock”), and is the size of an industrial warehouse. These rocks were stranded out on the prairie when the ice melted away and were left sitting out on the prairies.

I took the photo shown below of the Okotoks rock in 2011. For scale, notice the woman at the right. The big rock is now preserved as a park. The city of the same name is outside the photo to the right. You can just see one house of a suburb. The rock is isolated on the flatlands. There are no outcrops nearby.

The final ice melt was not as most people think, where the front of the ice sheets gradually pulled back like modern-day glaciers. Rather the source of the ice sheets, deep inside the Rocky Mountains (Cordilleran) or in Nunavut (Laurentide), stopped accumulating more snow than melted each summer.

The ice sheets began melting in place, breaking into segments and slowly dwindling. This disrupted the ecosystems and many species came under stress. Then the first humans arrived in North America. When *Homo sapiens* began spreading out of Africa, everywhere they went the megafauna quickly declined and became extinct.

Humans entering North America first eradicated all the large species such as mammoths and mastodons, then camels and horses. The ecological disasters that followed finally sank in.

With only the bison left as a major source of food, the aboriginals realized they had to be careful. (Deer, moose, and elk do not roam in vast herds like bison and are more difficult to hunt in forests. Thus they survived.) The arrival of Europeans upset ecosystems once more.

The book wrapped up with a review of modern day conservation measures or lack thereof. For example, British Columbians along the coast dump their sewage raw into the ocean. Not just fishing villages but Greater Vancouver and the Fraser River delta. Hundreds of millions of litres per year. (They then lecture Alberta about the Athabasca Tar Sands.)

On the prairies, bison and prairie dogs are making a comeback as conservation programmes take effect.





**COZY MYSTERIES: PART 14**

by Dale Speirs

[Parts 1 to 13 appeared in OPUNTIA's #361, 379, 395, 398, 400, 420, 423, 443, 445, 449, 466, 482, and 525.]

Cozy mysteries had their origin with the Miss Marple stories but the modern versions are American. These days, cozies involve a middle-aged woman who has her own business in a village. She trips over fresh corpses at least once per novel and often more.

Such women often have weird shops that couldn't possibly pay in the big city, much less a rural village. My favourites are a series whose protagonist had a typewriter repair shop in a modern-day Colorado ski resort, and another who was a puppet maker in backwoods Ontario.

The better series use more plausible businesses such as a bakery or café. More modern series will mention that Miss Marple sells online. Some of them travel to fairs or conventions to spread the murders about instead of decimating their village.

The local Deputy Dawgs frequently suspect her or a close friend as the culprit, forcing her into sleuthing to identify the real murderer. Cozy heroines generally commit numerous crimes such as contaminating evidence, break-and-enter, impersonation, and obstructing police.

Many cozies still use fake suspense such as her forgetting to recharge her cellphone or leaving the device at home so she can't call for help. She goes to encounters with the killer in remote areas without telling anyone. Generally she is saved by the last-second arrival of police instead of freeing herself on her own.

Why do I read them? Well, they are mostly set in rural villages. I grew up in the cattle country of west-central Alberta and know real village life quite well. No Miss Marples out there, so I read these books as light comedy.

**Jessica.**

There is only one Jessica of course. Jessica Fletcher was the protagonist of MURDER, SHE WROTE, a television mystery series from 1984 to 1997.

Although the show is long gone, novels were published long after, bylined as "Jessica Fletcher and [name of ghostwriter]".

Fletcher lived in Cabot Cove, Maine, population 3,560, where most of the early murders were concentrated. Fans of the show calculated the town's murder rate at 149 per 100,000 on a per capita basis, which made the town the murder capital of the world.

In later episodes and novels, she went traveling so as to spread the murders around. People were talking in Cabot Cove, you know. Given her ability to sniff out bodies faster than any bloodhound, one wonders why she hadn't been hired to solve the Jimmy Hoffa disappearance.

BRANDY AND BULLETS (1995) by Jessica Fletcher and Donald Bain took place in Cabot Cove but adopted the work-around of killing off visitors to the village, sparing the remaining inhabitants.

The Worrell Institute for Creativity had just been opened in a unused mansion of the village. The institute was to be an artist colony where great works would be created.

As the reader will correctly anticipate, great murders would be committed. The WIC had a Behavioral Sciences unit to improve the efficiency of artists, a spa, an Addictions Centre, and all the other necessities of the artistic life.

Even Fletcher was surprised at the rapidity of the first murder, on opening night. Since the victim was an outlander, the villagers excluded her murder from the death toll.

The back stories were especially convoluted. The CIA denied any knowledge of the WIC when the evidence suggested the spooks were using the place for psywar experiments. The loose threads at the end of the novel were not tied off.

To the contrary, the threads were burned by people who said they didn't exist, nothing happened, and supposing something had, the agency wasn't responsible. The WIC collapsed as fast as it had sprung up. The only good news was that the events gave Fletcher the plot for her next novel.

A DEADLY JUDGEMENT (1996) by Jessica Fletcher and Donald Bain took Fletcher to Boston, where a few more murders would not be noticed. Her



lawyer friend Malcolm McLoon (really?) was defending William Brannigan, a millionaire charged with murdering his older brother Jack.

The defense’s problem was the death rate among the witnesses and jurors, not to mention attempts on Fletcher’s life. Obviously the culprit failed to realize she was booked for the series.

The denouement was in the courtroom in the finest Perry Mason tradition, where legal procedure went out the window and histrionics abounded. There were two separate murderers, one for Jack and the other for the jurors, for two different but intertwining motives.

Fletcher wrapped up the case for the judge and introduced evidence with no proper chain of custody or fair disclosure. Where’s Raymond Burr when you really need him?

**The Business Of Marpleing.**

DEAD COW IN AISLE THREE (2001) by H. Mel Malton was the third novel in a cozy series about Polly Deacon of Laingford, Ontario, in the cottage district of Muskoka. As per standard Marple economics, she earned her living in the remote backwoods as a puppet maker. Hopefully she had a lot of Internet sales.

The village was in an uproar because the supermarket chain Kountry Pantree was building a big-box store on the outskirts. The new store would kill the central business district.

Polly was deemed a traitor because the store management hired her to build a mascot costume for them. She had to eat, so money came before civic pride.

Her Aunt Susan, leader of the League of Social Justice, was disappointed in her. Susan’s farm supply business had been crushed by an earlier big-box outlet called Agri-Am, so the conflict was personal with her.

The Kountry Pantree public relations committee couldn’t agree what the mascot would be. Moose and beaver mascots were ruled out, so they narrowed the choices down to a cow, a Canada goose, or a gopher. (Are there gophers in Muskoka? Just asking. I’ve never been there.) The final decision was for Kountry Kow.

The alarums weren’t much to be going on with. One guy fell into the river and went over a waterfall. He survived to say he was pushed, but out there in the forest there were no witnesses or surveillance cameras. The League held meetings which went nowhere. Charges of corruption were made against councillors but nothing was done.

The Kountry Pantree owner was murdered while he was wearing the Kountry Kow suit. The killer promptly blubbered all instead of keeping her mouth shut. With a rush, loose ends were tied up, and a few more left unraveled for the next novel.

FLEECE, NAVI, DEAD (2021) was written by Joanna Campbell Slan. Please note those commas in the title; they were there in the original. This was the 16<sup>th</sup> novel in a cozy series about Kiki Lowenstein of Saint Louis, Missouri. She operated a crafts store, was preparing her daughter’s bat mitzvah, and teaching an arts course. She still had time to Marple.

Besides all the domestic crises, there was a stalker after a young woman. As Hanukkah proceeded, the omens and family feuds accumulated while Kiki tripped through the middle. Too busy teaching pottery. White trash were everywhere.

The denouement was a hostage taking that ended in blood, but with a Merry Christmas to one and all. Puzzling since the majority were Jews. Not the usual type of cozy, more like a noir.

ROUND UP THE USUAL PEACOCKS (2022) by Donna Andrews was the 31<sup>st</sup> novel in a cozy series about Meg Langslow of Caerphilly, Virginia. Once upon a time she had a business but now was a mother and homemaker who still Marpled.

She was involved with wedding plans for her brother Rob and his fiancée Delaney, a few days hence. Her nephew Kevin, a computer geek who rented her basement suite, was worried about a potential crime that might hit the family.

The wedding plans included peacocks strolling about the garden during the reception. The Langslow patriarch, Meg’s father, raised them among other critters in his menagerie. Trouble was, the birds were molting, an annual occurrence that had been overlooked. Mangy peacocks wouldn’t do.



Kevin had his troubles too. He and his friend Casey had a podcast called “Virginia Crime Time” which dealt in cold cases. Someone made an attempt on Casey’s life, indicating the duo was bothering at least one perpetrator.

Kevin feared there might be an attack at the wedding on him. He had done much searching online and narrowed the possibilities down to three cold cases. He was no good at talking to people face-to-face to continue his research. On the other hand, his Aunt Meg was famous throughout the county as a Miss Marple, so he dragooned her into sleuthing for him.

She was a busy woman but she could listen to his podcasts while running errands around town for the wedding. They narrowed down the list. Meg did her usual good job of stirring up ghosts from the past and antagonizing people who wanted the past to stay as dead as their victims.

She solved what seemed to be the biggest cold case. The wedding went off without a hitch. In lieu of peacocks, there were show chickens, bred for their colourful plumage, not eggs or meat. The llamas looked nice too.

**A Bicycle Built For Murder.**

GEARED FOR THE GRAVE (2014) by Duffy Brown was the first novel in a cozy series about Evie Bloomfield of Mackinac Island, Michigan, in the waters of Lake Huron.

A Chicago ad agency flunky, Evie wound up on the island to assist her boss’ father Rudy Randolph. He had broken his leg and couldn’t operate his bicycle rental shop properly. Motor vehicles other than emergency or public service were not allowed on the island, so bicycles were important and profitable.

Bunny Harrington, a customer of Rudy’s, died in a bike accident. The brakes had been cut. She and Rudy were well known as enemies, so Evie went sleuthing to save Rudy and her job.

Since Evie was new to the island, this allowed infodumps about life on a tourist island and lots of back stories to unfold. The deceased had been an unpleasant woman, so there was no shortage of suspects. She was a blackmailer on the side, always guaranteed to shorten a lifespan.

The ending was a tomato surprise. The culprit was a competitor of Evie’s employer who were trying to distract the Randolph family during a contract tender.

BRAKING FOR BODIES (2016) by Duffy Brown was the sequel. Evie Bloomfield was now in charge of the rental bicycle shop where the most stressful thing in her life was the planning for the Lilac Festival.

A boatload of tourists brought with them a tabloid editor known as Peephole Perry. When he was found dead, suspicion settle on Evie’s friend Fiona, who had once worked for him and regretted it.

Evie was helping a friend with her wedding preparations, even more stressful than a murder. She spent little time in the bicycle shop as a consequence. Marpleing duties such as break-and-enter took precedence.

Perry’s mistress and his wife, both as poorly behaved as him, were annoyed he was going to ditch them for a third woman. Lots of shouting and misdirection, with an occasional bicycle ride.

**Dead And Breakfast.**

GONE WITH THE TWINS (2017) by Kylie Logan (pseudonym of Connie Laux) was set on South Bass Island, Ohio, off the shore of Lake Erie. The place was one big soap opera, where everyone, including the narrator Bea Cartwright, had a past. And, equally perturbing, a present.

Bea belonged to the League of Literary Ladies, a book club of four women right in the middle of those soap operas. She operated a bed-and-breakfast which was losing guests to a new competitor called Tara. It was operated by C-list celebrities who fashioned it after a Southern plantation. Just what Ohio needed.

The real excitement was Vivien Frisk, a sharp-practice real estate agent who did one fancy deal too many. Her murder came as little surprise to the villagers. One of the suspects was a member of the League, so Bea and the rest went Marpleing.

Break-ins galore, common assaults, and all manner of alarums that would frighten away a Chicago gang. Bea was whacked unconscious. Someone was sabotaging her bed-and-breakfast with fake bad reviews online.



The grand finale was at the Chamber of Commerce gala when Bea put together the last clues. The celebrities had done the murder because Frisk was blackmailing them for previous sins and indictable offenses. They fled but were caught and thereupon blabbed all. It was Bea's turn to be a celebrity.

**Murder Under Glass.**

Like websites, there is no end to how specialized cozy mysteries can be. There are enough novels about Miss Marples in the glassware business to create a sub-genre.

A SHATTERING CRIME (2016) by Jennifer McAndrews was a novel in a cozy series about Georgia Kelly of Wenwood, New York, somewhere upstream on the Hudson River. She operated a stained glass business, worked part-time as a clerk, and waited tables in the evening. Plus Marpleing, of course, but that didn't pay.

The village was redeveloping the waterfront, a project afflicted by environmentalists. For some strange reason, they object to rundown buildings being replaced by modern buildings. The leader of the group was poisoned, and suspicion fell on the baker, named Rozelle.

She was a friend of Georgia, so that triggered the Marpleing. A busy time for Georgia, whose mother and new stepfather dropped in for a stay. Plus her cat went into heat. There's never a dull moment in Wenwood.

The alarums and disputations continued. There were pauses every so often for Georgia to fire some glass in a kiln, or cut and polish scrap pieces to make jewelry. The back stories and new alarums progressed, such as Rozelle suddenly disappearing.

The grand finale was a near-fatal confrontation with the murderer, who resented the protestors interfering with her redevelopment project. Georgia survived, as the reader knew she would, since she was booked for the series. Oh, and the cat was spayed.

CRACKED TO DEATH (2016) by Cheryl Hollon was a novel in a cozy series about Savannah Webb of Saint Petersburg, Florida. She operated a glassware shop, assisted by Amanda Blake.

The disposable character was Martin Lane, a beachcomber who found two antique bottles. The next day his body washed ashore, along with a third bottle.

The age and rarity of the bottles suggested he had found a treasure site. His head and spine had been bashed in with a blunt instrument, so he didn't drown while snorkeling. Blake had prior connections with him and became a suspect. Webb was therefore the designated Marple.

She had a crafts class underway in the glass shop but managed to get in quite a bit of sleuthing. Blake wandered about, drawing the maximum amount of suspicion to herself by her behaviour.

The alarums concluded with a three-way gun battle on the Intracoastal Waterway. The participants included Miss Marple and company, a fellow treasure hunter of Lane who wanted all the loot for himself, and a fraudster who was duplicating the bottles and selling the fakes as originals for \$3,000 apiece.

Not included in the firefight were the police but they arrived in the nick of time. And so back to the humdrum of retailing stained glass.

**Death On The Maine Coast, Sans Jessica.**

INVITATION ONLY MURDER (2019) by Leslie Meier was the 31<sup>st</sup> novel in a cozy set in Tinker's Cove, Maine. You-know-who lived further down the coast and wasn't available, so the resident sleuth was Lucy Stone, a part-time newspaper reporter.

The plot began when Lucy received an invitation to attend a grand fete given by billionaire Scott Newman. The event was held on his estate, Fletcher's Island. (Pause for laughter from the audience.) Evidently Newman didn't know much about life along the Maine coast.

Lucy was the one who found one of Newman's daughters dead at the base of a seaside cliff. Was it an accident or was she pushed? Obviously the latter, otherwise this would be a short story, not a novel.

The back stories, old feuds, and gossip intensified on the island. Also ghosts, some children mysteriously disappearing, sabotage, and other assorted alarums. I'm glad I live in Calgary where we only have to worry about the occasional stampede of horses. (A true story; I'll tell it in some future issue of this zine.)



Scott was a full-blown paranoid, and not without justification. Eventually he, Lucy, and the islanders discovered too late that one of his other daughters was even further beyond our ken. She had killed her sister in a fit of jealousy, and almost got Lucy the same way at the same cliff.

**Travel Hopefully.**

FROM BAD TO WURST (2015) by Maddy Hunter was a novel in a cozy series about a group of globe-trotting Iowa seniors. Imagine multiple Miss Marples spreading murder about the planet like a Wuhan tourist spreading coronavirus.

Twas Oktoberfest and Germany was about to suffer the effects of the Iowans, who by now should have been on an Interpol watch list. The tour group included four Iowa brass bands oom-pah-bah-ing in Munich’s beer halls.

Tragedy struck as they were walking past a waterworks excavation in the street. A backhoe hit an unexploded WW2 bomb, detonating the device. Among the dead was one of the tour group Astrid Peterson.

A pall was cast on the rest of the tour but they decided to carry on. The deceased had been an accordionist in one of the Iowa bands. She, and this is difficult to explain, liked to bed lots of men but not for sex.

She carried knockout drops and fed her man of the night a delicious meal with a rich dessert designed to put him to sleep just as they got into bed. All she wanted was someone warm to cuddle and spoon with. That was the gist of the plot. Plus a tour of Bavaria, oom-pah-bah.

**ZINE LISTINGS**

[I only list zines I receive from the Papernet. If the zine is posted on [www.efanzines.com](http://www.efanzines.com) or [www.fanac.org](http://www.fanac.org), then I don’t mention it since you can read it directly.]

FOR THE CLERISY #93 (Available for The Usual from Brant Kresovich, Box 404, Getzville, New York 14068-0404) Review zine of older books worth renewed attention.

THE FOSSIL #395 (US\$10 from The Fossils, c/o Tom Parson, 157 South Logan Street, Denver, Colorado 80209) This publication is devoted to the history of zines.

The issue at hand has articles about past zinesters from the 1870s to the 1970s, a correspondent of H.P. Lovecraft, a young woman who attended an 1885 zine convention, and fun with ChatGPT as it tried to write articles about the history of zines or Lovecraft.

**WORLD WIDE PARTY ON JUNE 21**

Founded by Benoit Girard (Quebec) and Franz Miklis (Austria) in 1994, the World Wide Party is held on June 21st every year. 2023 will be the 30th year of the WWP. Mark your calendars now!

At 21h00 local time, everyone is invited to raise a glass and toast fellow members of zinedom around the world. It is important to have it exactly at 21h00 your time.

The idea is to get a wave of fellowship circling the planet. Rescheduling it to a club meeting or more convenient time negates the idea of a wave of celebration by SF fans and zinesters circling the globe.

At 21h00, face to the east and salute those who have already celebrated. Then face north, then south, and toast those in your time zone who are celebrating as you do. Finally, face west and raise a glass to those who will celebrate WWP in the next hour.

Raise a glass, publish a one-shot zine, have a party, or do a mail art project for the WWP. Let me know how you celebrated the day.



SEEN IN THE LITERATURE

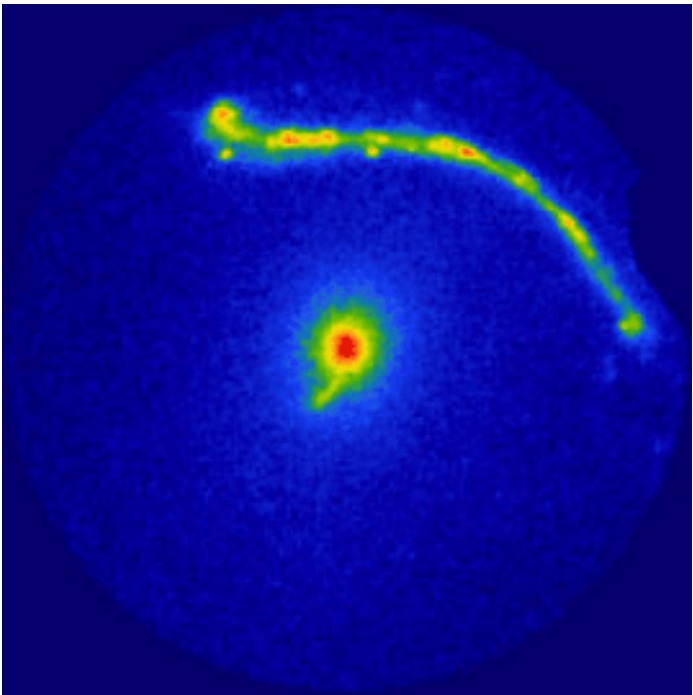
Astronomy.

Nightingale, J.W., et al (2023) **Abell 1201: detection of an ultramassive black hole in a strong gravitational lens.** MONTHLY NOTICES OF THE ROYAL ASTRONOMICAL SOCIETY 521:doi.org/10.1093/mnras/stad587 (available as a free pdf)

Authors’ abstract: *Supermassive black holes (SMBHs) are a key catalyst of galaxy formation and evolution, leading to an observed correlation between SMBH mass  $M_{\text{BH}}$  and host galaxy velocity dispersion  $\sigma_e$ .*

*Outside the local Universe, measurements of  $M_{\text{BH}}$  are usually only possible for SMBHs in an active state, limiting sample size and introducing selection biases. Gravitational lensing makes it possible to measure the mass of non-active SMBHs.*

*We present models of the  $z = 0.169$  galaxy-scale strong lens Abell 1201. A cD galaxy in a galaxy cluster, it has sufficient ‘external shear’ that a magnified image of a  $z = 0.451$  background galaxy is projected just  $\sim 1$  kpc from the galaxy centre.*



[The image is from this paper and shows how the black hole warped an image of a galaxy behind it.]

Emonts, B.H.C., et al (2023) **A cosmic stream of atomic carbon gas connected to a massive radio galaxy at redshift 3.8.** SCIENCE 379:1323-1326

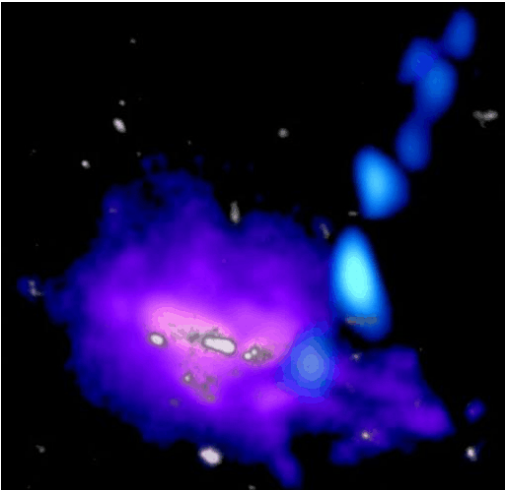
Authors’ abstract: *Galaxies grow by accreting material, either in mergers with other galaxies or from gas in the intergalactic medium. We used submillimeter observations to map the atomic carbon gas around a massive galaxy at redshift 3.8, early in a period known as cosmic noon, when galaxies were rapidly assembling.*

*We identified a stream of cold gas several times the size of the galaxy extending away from it into the intergalactic medium. The mass of gas in the stream would be sufficient to maintain star formation in the galaxy for hundreds of millions of years if it is accreted.*

*The growth of galaxies in the early Universe is driven by accretion of circum- and intergalactic gas. Simulations have predicted that steady streams of cold gas penetrate the dark matter halos of galaxies and provide the raw material necessary to sustain star formation.*

*We report a filamentary stream of gas that extends for 100 kiloparsecs and connects to the massive radio galaxy 4C 41.17. We detected the stream using submillimeter observations of the  $^3P_1$  to  $^3P_0$  emission from the [C i] line of atomic carbon, a tracer of neutral atomic or molecular hydrogen gas.*

*The galaxy contains a central gas reservoir that is fueling a vigorous starburst. Our results show that the raw material for star formation can be present in cosmic streams outside galaxies.*



[Image is from this paper and shows a streamer of cold gas falling into a galaxy.]



Maund, J.R., et al (2023) **A flash of polarized optical light points to an aspherical ‘cow’.** MONTHLY NOTICES OF THE ROYAL ASTRONOMICAL SOCIETY 521:doi.org/10.1093/mnras/stad539

Authors’ abstract: *The astronomical transient AT2018cow is the closest example of the new class of luminous, fast blue optical transients (FBOTs). Liverpool Telescope RINGO3 observations of AT 2018cow are reported here, which constitute the earliest polarimetric observations of an FBOT.*

*At 5.7 days post-explosion, the optical emission of AT2018cow exhibited a chromatic polarization spike that reached ~7% at red wavelengths. This is the highest intrinsic polarization recorded for a non-relativistic explosive transient, and is observed in multiple bands and at multiple epochs over the first night of observations, before rapidly declining.*

*The apparent wavelength dependence of the polarization may arise through depolarization or dilution of the polarized flux, due to conditions in AT 2018cow at early times. A second ‘bump’ in the polarization is observed at blue wavelengths at ~12 days.*

*Such a high polarization requires an extremely aspherical geometry that is only apparent for a brief period (<1 day), such as shock breakout through an optically thick disk. For a disk-like configuration, the ratio of the thickness to radial extent must be ~10%.*

[Image is from this paper. Just like a Klingon planet exploding.]



**Planets.**

Lobo, A.H., et al (2023) **Terminator habitability: The case for limited water availability on M-dwarf planets.** ASTROPHYSICAL JOURNAL 945:doi.org/10.3847/1538-4357/aca970 (available as a free pdf)

Authors’ abstract: *Rocky planets orbiting M-dwarf stars are among the most promising and abundant astronomical targets for detecting habitable climates.*

*Planets in the M-dwarf habitable zone are likely synchronously rotating, such that we expect significant day-night temperature differences and potentially limited fractional habitability.*

*Previous studies have focused on scenarios where fractional habitability is confined to the substellar or “eye” region, but in this paper we explore the possibility of planets with terminator habitability, defined by the existence of a habitable band at the transition between a scorching dayside and a glacial nightside.*

*Using a global climate model, we show that for water-limited planets it is possible to have scorching temperatures in the “eye” and freezing temperatures on the nightside, while maintaining a temperate climate in the terminator region, due to reduced atmospheric energy transport.*

*On water-rich planets, however, increasing the stellar flux leads to increased atmospheric energy transport and a reduction in day-night temperature differences, such that the terminator does not remain habitable once the dayside temperatures approach runaway or moist greenhouse limits.*

*We also show that while water abundant simulations may result in larger fractional habitability, they are vulnerable to water loss through cold trapping on the nightside surface or atmospheric water vapor escape, suggesting that even if planets were formed with abundant water, their climates could become water-limited and subject to terminator habitability.*



Roccetti, G., et al (2023) **Presence of liquid water during the evolution of exomoons orbiting ejected free-floating planets.** INTERNATIONAL JOURNAL OF ASTROBIOLOGY 14:doi.org/10.1017/S1473550423000046 (available as a free pdf)

Authors' abstract: *Free-floating planets (FFPs) can result from dynamical scattering processes happening in the first few million years of a planetary system's life. Several models predict the possibility, for these isolated planetary-mass objects, to retain exomoons after their ejection.*

*The tidal heating mechanism and the presence of an atmosphere with a relatively high optical thickness may support the formation and maintenance of oceans of liquid water on the surface of these satellites.*

*In order to study the timescales over which liquid water can be maintained, we perform dynamical simulations of the ejection process and infer the resulting statistics of the population of surviving exomoons around FFPs.*

*The subsequent tidal evolution of the moons' orbital parameters is a pivotal step to determine when the orbits will circularize, with a consequential decay of the tidal heating.*

*We find that close-in Earth-mass moons with carbon dioxide-dominated atmospheres could retain liquid water on their surfaces for long timescales, depending on the mass of the atmospheric envelope and the surface pressure assumed.*

*Massive atmospheres are needed to trap the heat produced by tidal friction that makes these moons habitable. For Earth-like pressure conditions (1 bar), satellites could sustain liquid water on their surfaces up to 52 megayears.*

*For higher surface pressures (10 and 100 bar), moons could be habitable up to 276 megayears and 1.6 gigayears, respectively. Close-in satellites experience habitable conditions for long timescales, and during the ejection of the FFP remain bound with the escaping planet, being less affected by the close encounter.*

Young, E.D., et al (2023) **Earth shaped by primordial H<sub>2</sub> atmospheres.** NATURE 616:306-311

Authors' abstract: *Earth's water, intrinsic oxidation state and metal core density are fundamental chemical features of our planet. Studies of exoplanets provide a useful context for elucidating the source of these chemical traits.*

*Planet formation and evolution models demonstrate that rocky exoplanets commonly formed with hydrogen-rich envelopes that were lost over time. These findings suggest that Earth may also have formed from bodies with hydrogen-rich primary atmospheres.*

*Here we use a self-consistent thermodynamic model to show that Earth's water, core density and overall oxidation state can all be sourced to equilibrium between hydrogen-rich primary atmospheres and underlying magma oceans in its progenitor planetary embryos.*

*Water is produced from dry starting materials resembling enstatite chondrites as oxygen from magma oceans reacts with hydrogen. Hydrogen derived from the atmosphere enters the magma ocean and eventually the metal core at equilibrium, causing metal density deficits matching that of Earth.*

*Oxidation of the silicate rocks from solar-like to Earth-like oxygen fugacities also ensues as silicon, along with hydrogen and oxygen, alloys with iron in the cores.*

*Reaction with hydrogen atmospheres and metal-silicate equilibrium thus provides a simple explanation for fundamental features of Earth's geochemistry that is consistent with rocky planet formation across the Galaxy.*

Hahn, R.M., and P.K. Byrne (2023) **A morphological and spatial analysis of volcanoes on Venus.** JOURNAL OF GEOPHYSICAL RESEARCH: PLANETS 128:doi.org/10.1029/2023JE007753 (available as a free pdf)

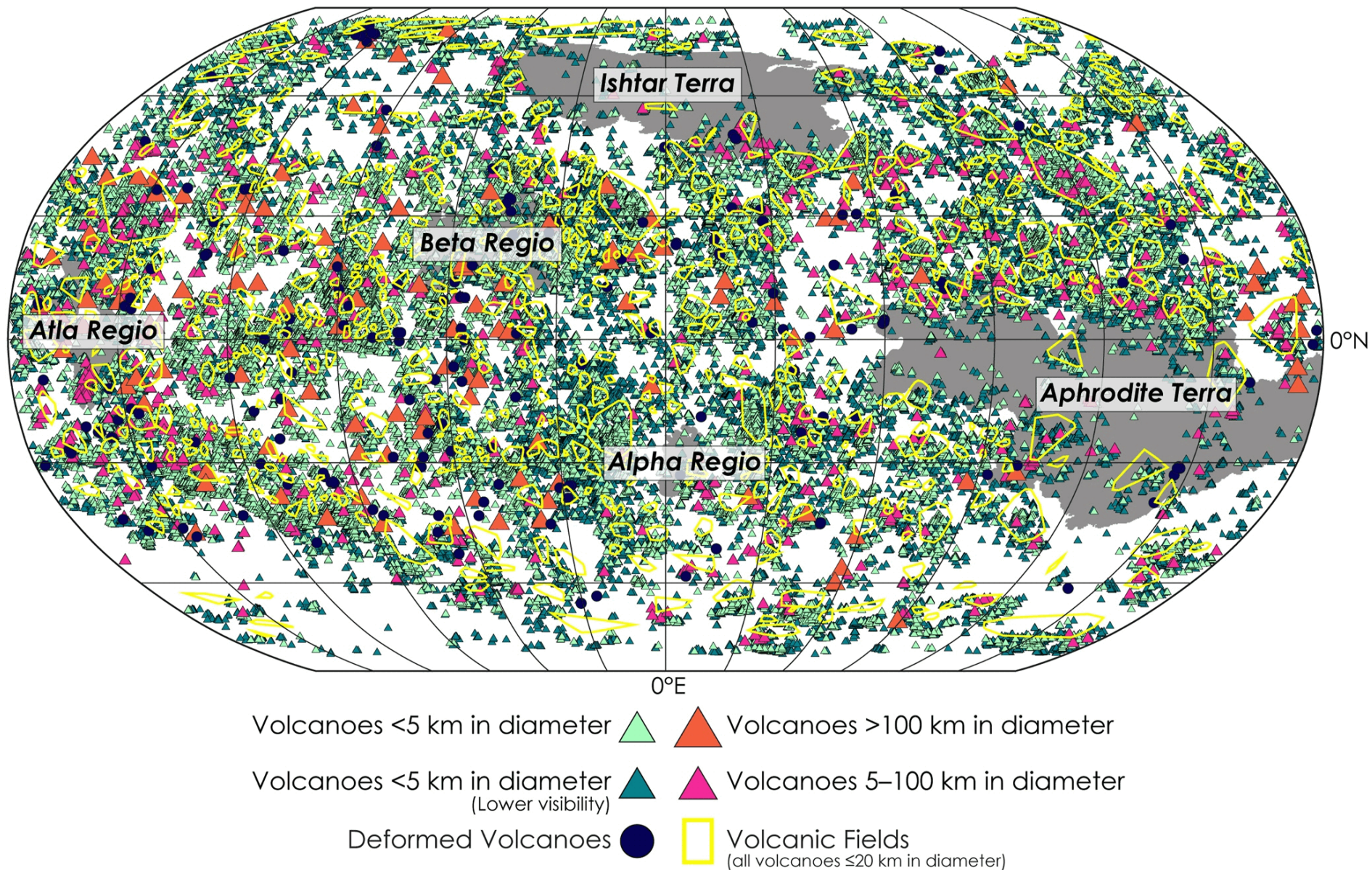
Authors' abstract: *Venus is home to many thousands of volcanic landforms that range in size from much less than 5 km to well over 100 km in diameter. Volcanism is clearly a major, widespread process on Venus, and is a principal expression of the planet's secular loss of interior heat.*

Without sufficient in situ data to clearly determine its internal structure, we can use the morphological and spatial properties of volcanoes across the planet to help place constraints on our understanding of the volcanic characteristics and history of Venus.

With the Magellan synthetic-aperture radar full-resolution radar map left- and right-look global mosaics at 75 m-per-pixel resolution, we developed a global catalog of volcanoes on Venus that contains ~85,000 edifices, ~99% of which are <5 km in diameter.

We find that Venus hosts far more volcanoes than previously mapped, and that although they are distributed across virtually the entire planet, size-frequency distribution analysis reveals a relative lack of edifices in the 20 to 100 km diameter range, which could be related to magma availability and eruption rate.

[Map is from this paper.]





Honing, D., and T. Spohn (2023) **Land fraction diversity on Earth-like planets and implications for their habitability.** ASTROBIOLOGY 23:doi.org/10.1089/ast.2022.0070 (available as a free pdf)

Authors' abstract: *A balanced ratio of ocean to land is believed to be essential for an Earth-like biosphere, and one may conjecture that plate-tectonics planets should be similar in geological properties. After all, the volume of continental crust evolves toward an equilibrium between production and erosion.*

*If the interior thermal states of Earth-sized exoplanets are similar to those of Earth, a straightforward assumption due to the temperature dependence of mantle viscosity, one might expect a similar equilibrium between continental production and erosion to establish, and hence a similar land fraction.*

*We show that this conjecture is not likely to be true. Positive feedback associated with the coupled mantle water-continental crust cycle may rather lead to a manifold of three possible planets, depending on their early history: a land planet, an ocean planet, and a balanced Earth-like planet.*

*In addition, thermal blanketing of the interior by the continents enhances the sensitivity of continental growth to its history and, eventually, to initial conditions. Much of the blanketing effect is, however, compensated by mantle depletion in radioactive elements.*

*A model of the long-term carbonate-silicate cycle shows the land and the ocean planets to differ by about 5K in average surface temperature. A larger continental surface fraction results both in higher weathering rates and enhanced outgassing, partly compensating each other.*

*Still, the land planet is expected to have a substantially dryer, colder, and harsher climate possibly with extended cold deserts in comparison with the ocean planet and with the present-day Earth.*

*Using a model of balancing water availability and nutrients from continental crust weathering, we find the bioproductivity and the biomass of both the land and ocean planets to be reduced by a third to half of those of Earth. The biosphere on these planets might not be substantial enough to produce a supply of free oxygen.*

Rucker, H.R., et al (2023) **Quantifying the bioavailable energy in an ancient hydrothermal vent on Mars and a modern earth-based analog.** ASTROBIOLOGY 23:doi.org/10.1089/ast.2022.0064

[The Noachian period on Mars was 4,100 to 3,700 megayears ago. Gibbs energy is the amount of free energy available for reactions in a chemical system.]

Authors' abstract: *Putative alkaline hydrothermal systems on Noachian Mars were potentially habitable environments for microorganisms. However, the types of reactions that could have fueled microbial life in such systems and the amount of energy available from them have not been quantitatively constrained.*

*In this study, we use thermodynamic modeling to calculate which catabolic reactions could have supported ancient life in a saponite-precipitating hydrothermal vent system in the Eridania basin on Mars. To further evaluate what this could mean for microbial life, we evaluated the energy potential of an analog site in Iceland, the Strytan Hydrothermal Field.*

*Results show that, of the 84 relevant redox reactions that were considered, the highest energy-yielding reactions in the Eridania hydrothermal system were dominated by methane formation.*

*By contrast, Gibbs energy calculations carried out for Strytan indicate that the most energetically favorable reactions are CO<sub>2</sub> and O<sub>2</sub> reduction coupled to H<sub>2</sub> oxidation.*

*In particular, our calculations indicate that an ancient hydrothermal system within the Eridania basin could have been a habitable environment for methanogens using NH<sub>4</sub><sup>+</sup> as an electron acceptor.*

*Differences in Gibbs energies between the two systems were largely determined by oxygen, its presence on Earth and absence on Mars. However, Strytan can serve as a useful analog for Eridania when studying methane-producing reactions that do not involve O<sub>2</sub>.*

Coleine, C., et al (2023) **Rock traits drive complex microbial communities at the edge of life.** ASTROBIOLOGY 23:doi.org/10.1089/ast.2022.0062

Authors’ abstract: *Antarctic deserts are among the driest and coldest ecosystems of the planet; there, some microbes survive under these extreme conditions inside porous rocks, forming the so-called endolithic communities. Yet the contribution of distinct rock traits to support complex microbial assemblies remains poorly determined.*

*Here, we combined an extensive Antarctic rock survey with rock microbiome sequencing and ecological networks and found that contrasting combinations of microclimatic and rock traits such as thermal inertia, porosity, iron concentration, and quartz cement can help explain the multiple complex microbial assemblies found in Antarctic rocks.*

*Our work highlights the pivotal role of rocky substrate heterogeneity in sustaining contrasting groups of microorganisms, which is essential to understand life at the edge on Earth and for the search for life on other rocky planets such as Mars.*

**Origin Of Life.**

Babajanyan, S.G., et al (2023) **Co-evolution of reproducers and replicators at the origin of life and the conditions for the origin of genomes.** PROCEEDINGS OF THE NATIONAL ACADEMYS OF SCIENCES USA 120:doi.org/10.1073/pnas.2301522120 (available as a free pdf)

Authors’ abstract: *We present an evolutionary scenario in which cells evolved via symbiosis between protocells that harbored protometabolic reaction networks, could divide and were subject to selection, but lacked genomes, and primordial genetic elements (GE).*

*There are two fundamentally distinct but inextricably linked types of biological evolutionary units, reproducers and replicators. Reproducers are cells and organelles that reproduce via various forms of division and maintain the physical continuity of compartments and their content.*

*Replicators are genetic elements, including genomes of cellular organisms and various autonomous elements, that both cooperate with reproducers and rely on*

*the latter for replication. All known cells and organisms comprise a union between replicators and reproducers.*

*We explore a model in which cells emerged via symbiosis between primordial “metabolic” reproducers (protocells) which evolved, on short time scales, via a primitive form of selection and random drift, and mutualist replicators.*

*Mathematical modeling identifies the conditions, under which GE-carrying protocells can outcompete GE-less ones, taking into account that, from the earliest stages of evolution, replicators split into mutualists and parasites.*

*Analysis of the model shows that, for the GE-containing protocells to win the competition and to be fixed in evolution, it is essential that the birth-death process of the GE is coordinated with the rate of protocell division.*

*At the early stages of evolution, random, high-variance cell division is advantageous compared with symmetrical division because the former provides for the emergence of protocells containing only mutualists, preventing takeover by parasites.*

*These findings illuminate the likely order of key events on the evolutionary route from protocells to cells that involved the origin of genomes, symmetrical cell division, and anti-parasite defense systems.*

Pitsawong, W., et al (2023) **From primordial clocks to circadian oscillators.** NATURE 616:doi.org/10.1038/s41586-023-05836-9 (available as a free pdf)

[Kai proteins are bundles of long helical proteins that wind and unwind depending on exposure to light, thereby controlling circadian rhythms that most organisms, including humans have.]

Authors’ abstract: *Circadian rhythms play an essential part in many biological processes, and only three prokaryotic proteins are required to constitute a true post-translational circadian oscillator.*

*The evolutionary history of the three Kai proteins indicates that KaiC is the oldest member and a central component of the clock. Subsequent additions of KaiB and KaiA regulate the phosphorylation state of KaiC for time synchronization.*



*The canonical KaiABC system in cyanobacteria is well understood, but little is known about more ancient systems that only possess KaiBC. However, there are reports that they might exhibit a basic, hourglass-like timekeeping mechanism.*

*Here we investigate the primordial circadian clock in Rhodobacter sphaeroides, which contains only KaiBC, to elucidate its inner workings despite missing KaiA.*

*Using a combination of X-ray crystallography and cryogenic electron microscopy, we find a new dodecameric fold for KaiC, in which two hexamers are held together by a coiled-coil bundle of 12 helices.*

*This interaction is formed by the carboxy-terminal extension of KaiC and serves as an ancient regulatory moiety that is later superseded by KaiA. A coiled-coil register shift between daytime and night-time conformations is connected to phosphorylation sites through a long-range allosteric network that spans over 140 Å.*

*Our kinetic data identify the difference in the ATP-to-ADP ratio between day and night as the environmental cue that drives the clock. They also unravel mechanistic details that shed light on the evolution of self-sustained oscillators.*

*Circadian clocks are self-sustained biological oscillators that are ubiquitously found in prokaryotic and eukaryotic organisms. In eukaryotes, these systems are complex and highly sophisticated, whereas in prokaryotes, the core mechanism is regulated by a post-translational oscillator that can be reconstituted in vitro with ATP and three proteins (encoded by kaiA, kaiB and kaiC).*

*Seminal work on the KaiABC system has resulted in a comprehensive understanding of its circadian clock. KaiC is the central component that autophosphorylates by binding to KaiA and autodephosphorylates following association with KaiB.*

*The interplay among these three proteins has been shown in vitro to constitute a true circadian oscillator characterized by persistence, resetting and temperature compensation.*

*Consequently, the KaiABC system is considered an elegant and the simplest implementation of a circadian rhythm. The evolutionary history of kai genes established kaiC as the oldest member dating back around 3.5 billion years ago.*

*Subsequent additions of kaiB and most recently kaiA formed the extant kaiBC and kaiABC clusters, respectively. Notably, some studies of more primitive organisms that lack kaiA hinted that the kaiBC-based systems might already provide a basic, hourglass-like timekeeping mechanism.*

*Contrary to the self-sustained oscillators found in cyanobacteria, such a timer requires an environmental cue to drive the clock and for the daily flip of the hourglass.*

*The central role of circadian rhythms in many biological processes, controlled by the day and night cycle on Earth, makes their evolution a fascinating topic.*

**Paleobiology.**

[97% of all life became extinct at the end of the Permian. But what happened next during the Triassic?]

Wen, W., et al (2023) **First occurrence of hybodontid teeth in the Luoping Biota (Middle Triassic, Anisian) and recovery of the marine ecosystem after the end-Permian mass extinction.** PALAEOGEOGRAPHY, PALAEOCLIMATOLOGY, PALAEOECOLOG Y 617:doi.org/10.1016/j.palaeo.2023.111471 (available as a free pdf)

Authors' abstract: *Hybodont sharks were some of the most successful chondrichthyan lineages of all time, first occurring in the Devonian and becoming extinct in the Late Cretaceous.*

*The end-Permian mass extinction had a limited effect on hybodont sharks, but there are fewer records of hybodonts in the Triassic than in the Jurassic and Cretaceous in China.*

*The Middle Triassic Luoping Biota (Pelsonian, Anisian) is famous as an example of complete re- establishment of a shallow marine food web after the end-Permian mass extinction.*

*Actinopterygian fishes are abundant and diverse in this assemblage, with 31 taxa described, including Halecomorphi and Ginglymodi, but few chondrichthyan fishes.*

*The recovery of life from the end-Permian mass extinction is one of the most remarkable episodes in the history of life. Indeed, there was a massive change from the late Palaeozoic life in the oceans and on land to the new Triassic ecosystems.*

*The Triassic witnessed the origins of major new clades and life modes in the oceans, including modern crustaceans, gastropods, and fishes that enhanced predator-prey arms races, and collectively mark the origin of the 'Modern fauna' and the early beginning of the Mesozoic marine revolution with massive enhancement of energy consumption and predator-prey interaction*

Groenewald, D.P., et al (2023) **Fossil millipedes associated with articulated tetrapod skeletons in the Early Triassic Karoo Basin, South Africa.** PALAEOGEOGRAPHY, PALAEOCLIMATOLOGY, PALAEOECOLOGY 617:doi.org/10.1016/j.palaeo.2023.111508

[During the end-Permian mass extinction, fungi and millipedes did very well.]

Authors' abstract: *Millipede fossils of late Permian to Early Triassic age are exceptionally rare worldwide. Two specimens of Triassic millipedes, both associated with multitaxic tetrapod aggregations, have previously been reported from the South African Karoo Basin.*

*Taxa associated with millipede fossils include the cynodont Galesaurus planiceps and the parareptile Saurodekte kitchingorum (previously Owenetta kitchingorum). Here we report and briefly describe three new millipede tetrapod associations from the Early Triassic Lystrosaurus declivis Assemblage Zone.*

*The first includes two millipedes associated with an articulated small therocephalian Scaloposaurus constrictus, the second comprises an articulated skeleton of the dicynodont Lystrosaurus murrayi with a single millipede, and the third contains an articulated Lystrosaurus sp. specimen, also with a single millipede.*

*In all specimens the high degree of skeletal articulation which, coupled with in-situ preservation of delicate bones and millipede exoskeletons, suggest rapid burial soon after death, and likely that they died in a place protected from weathering and agents of dispersal.*

*Possible hypotheses to explain the presence of millipedes closely associated with articulated tetrapod skeletons include: shelter sharing, predator-prey accumulations, and post-mortem scavenging by the millipedes.*

*Of these, our taphonomic interpretation favours the latter. Within the Karoo Supergroup, the appearance of millipede fossils in the uppermost Balfour and lower Katberg formations suggests that the scarcity of plant detritus on the Karoo floodplains in the aftermath of the end-Permian mass extinction event may have contributed to millipedes switching to a more scavenging feeding strategy.*

Rietbergen, T.B., et al (2023) **The oldest known bat skeletons and their implications for Eocene chiropteran diversification.** PLOS ONE 18:doi.org/10.1371/journal.pone.0283505 (available as a free pdf)

Authors' abstract: *The Fossil Lake deposits of the Green River Formation of Wyoming, a remarkable early Eocene Lagerstätte (51.98±0.35 megayears ago), have produced nearly 30 bat fossils over the last 50 years.*

*However, diversity has thus far been limited to only two bat species. Here, we describe a new species of Icaronycteris based on two articulated skeletons discovered in the American Fossil Quarry northwest of Kemmerer, Wyoming.*

*The relative stratigraphic position of these fossils indicates that they are the oldest bat skeletons recovered to date anywhere in the world.*

*Phylogenetic analysis of Eocene fossil bats and living taxa places the new species within the family Icaronycteridae as sister to Icaronycteris index, and additionally indicates that the two Green River archaic bat families (Icaronycteridae and Onychonycteridae) form a clade distinct from known Old World lineages of archaic bats.*



Our analyses found no evidence that *Icaronycteris? menui* (France) nor *I. sigei* (India) belong to this clade; accordingly, we therefore remove them from *Icaronycteridae*.

Taken in sum, our results indicate that Green River bats represent a separate chiropteran radiation of basal bats, and provide additional support for the hypothesis of a rapid radiation of bats on multiple continents during the early Eocene.

[Image is from this paper.]

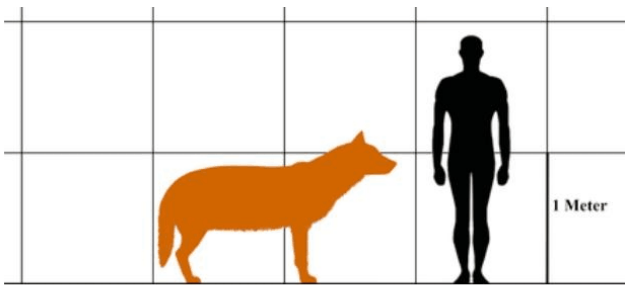


Skeleton of paratype of *Icaronycteris gunnelli* (ROM:Palaeobiology-Vertebrate Fossils:52666).

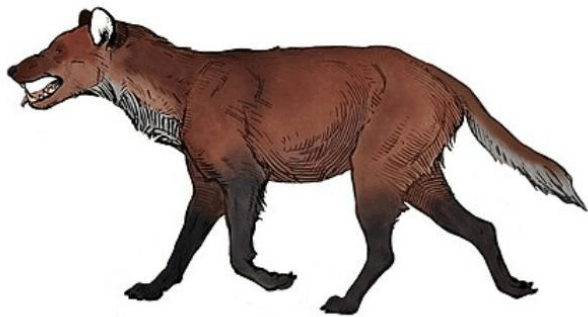
Reynolds, A.R., et al (2023) **Dire wolf (*Canis dirus*) from the late Pleistocene of southern Canada (Medicine Hat, Alberta).** JOURNAL OF QUATERNARY SCIENCE 38:doi.org/10.1002/jqs.3516 (available as a free pdf)

[The dire wolf was out-competed at the end of the Ice Ages by the grey wolf and coyotes, and became extinct.]

Authors’ abstract: *The dire wolf (Canis dirus) had a broad geographic range in Pleistocene North and South America. Its northernmost occurrence has been reported from late Pleistocene deposits in Medicine Hat, Alberta, representing the only record of the taxon in Canada.*



Size comparison with a human



However, the dentary upon which these reports were based has never been described or illustrated. The Medicine Hat specimen is badly crushed and appears to be from an old individual, which precludes the observation of adult diagnostic morphological characters.

Geometric morphometrics were used to test the previous identification of the Medicine Hat dentary. A landmark-based principal component analysis and a canonical variates analysis suggests that the specimen more strongly resembles dire wolf specimens than grey wolf (*Canis lupus*).

Identification of the Medicine Hat specimen as *C. dirus* supports it as the northernmost occurrence of this species in North America. However, we note the potential for allometric relationships that may confound differentiation between grey and dire wolves based on the morphology of the dentary.

[Images are from Wikipedia.]

Dinosaurs.

Cullen, T.M., et al (2023) **Theropod dinosaur facial reconstruction and the importance of soft tissues in paleobiology.** SCIENCE 379:doi.org/10.1126/science.abo7877 (available as a free pdf)

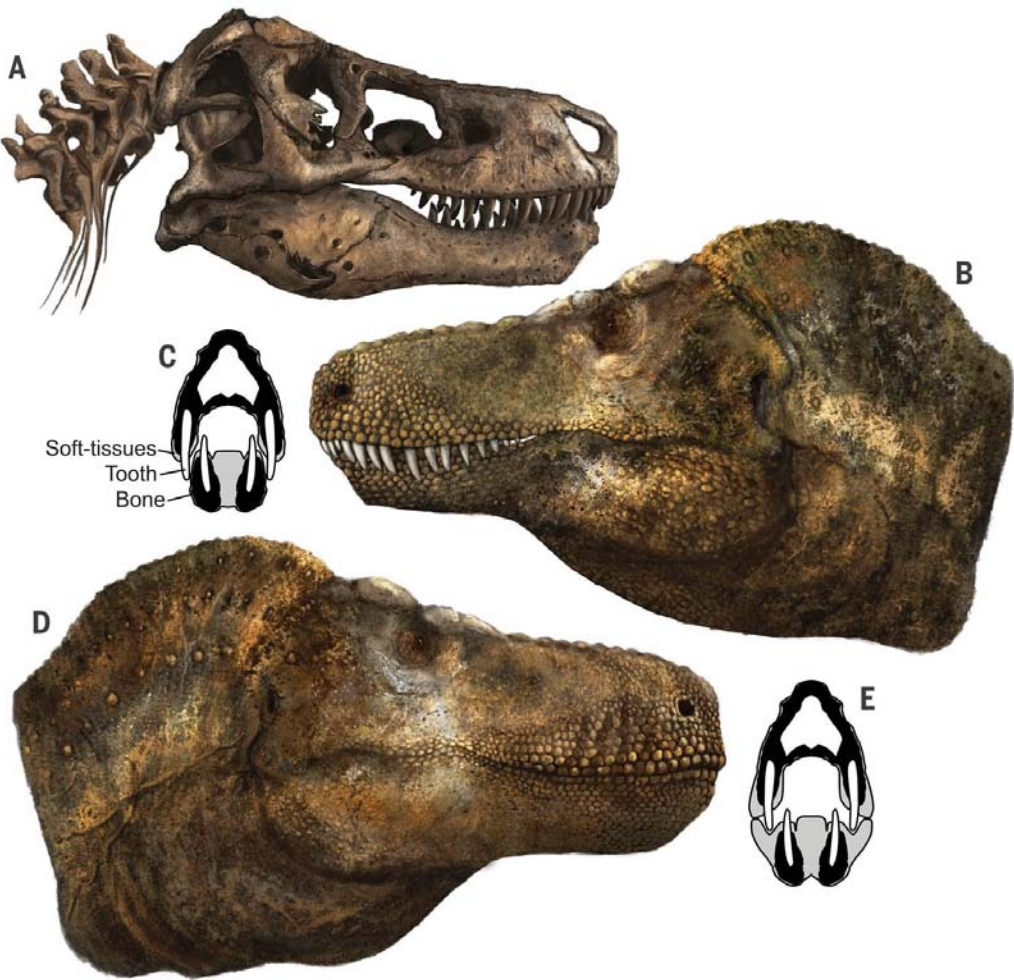
Authors’ abstract: Large theropod dinosaurs are often reconstructed with their marginal dentition exposed because of the enormous size of their teeth and their phylogenetic association to crocodylians. We tested this hypothesis using a multiproxy approach.

Regressions of skull length and tooth size for a range of theropods and extant varanid lizards confirm that complete coverage of theropod dinosaur teeth with extraoral tissues (gingiva and labial scales) is both plausible and consistent with patterns observed in living ziphodont amniotes.

Analyses of dental histology from crocodylians and theropod dinosaurs, including *Tyrannosaurus rex*, further indicate that the most likely condition was complete coverage of the marginal dentition with extra-oral tissue when the mouth was closed.

This changes our perceptions about the appearance and oral configuration of these iconic predators and has broad implications for our interpretations of other terrestrial animals with large teeth.

[Images are from this paper.]





Tagliavento, M., et al (2023) **Evidence for heterothermic endothermy and reptile-like eggshell mineralization in *Troodon*, a non-avian maniraptoran theropod.** PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES 120:doi.org/10.1073/pnas.2213987120

Authors’ abstract: *The dinosaur-bird transition is among the most fascinating events in evolutionary history, but several biological aspects such as changes in reproductive system, nesting strategy, and body temperature are still poorly understood.*

*Our results show that eggshells of modern reptiles and birds differ in their isotopic compositions. Interestingly, analyses of eggshells of *Troodon*, a non-avian theropod, reveal that it retained a slower, reptile-like mineralization to produce its eggs, despite having already evolved the capacity of changing its body temperature (heterothermic endothermy) like modern birds.*

*The dinosaur-bird transition involved several anatomical, biomechanical, and physiological modifications of the theropod bauplan. Non-avian maniraptoran theropods, such as *Troodon*, are key to better understand changes in thermophysiology and reproduction occurring during this transition.*

*Here, we applied dual clumped isotope thermometry, a technique that resolves mineralization temperature and other nonthermal information recorded in carbonates, to eggshells from *Troodon*, modern reptiles, and modern birds.*

**Troodon* eggshells show variable temperatures, namely  $42$  and  $29 \pm 2$  °C, supporting the hypothesis of an endothermic thermophysiology with a heterothermic strategy for this extinct taxon.*

*Dual clumped isotope data also reveal physiological differences in the reproductive systems between *Troodon*, reptiles, and birds. *Troodon* and modern reptiles mineralize their eggshells indistinguishable from dual clumped isotope equilibrium, while birds precipitate eggshells characterized by a positive disequilibrium offset.*

*Analyses of inorganic calcites suggest that the observed disequilibrium pattern in birds is linked to an amorphous calcium carbonate (ACC) precursor, a carbonate phase known to accelerate eggshell formation in birds.*

*Lack of disequilibrium patterns in reptile and *Troodon* eggshells implies these vertebrates had not acquired the fast, ACC-based eggshell calcification process characteristic of birds.*

*Observation that *Troodon* retained a slow reptile-like calcification suggests that it possessed two functional ovaries and was limited in the number of eggs it could produce; thus its large clutches would have been laid by several females.*

[From the Acknowledgments appendix] *We are especially grateful to Martin Stark for providing opportunity to collect freshly laid chicken eggs, as well as Zoo Leipzig, Zoo Hoyerswerda, and Zoo Frankfurt for kindly providing eggshells from reptiles and birds.*



**Zoology.**

Marlétaz, F., et al (2023) **The little skate genome and the evolutionary emergence of wing-like fins.** NATURE 616:doi.org/10.1038/s41586-023-05868-1 (available as a free pdf)

Authors’ abstract: *Skates are cartilaginous fish whose body plan features enlarged wing-like pectoral fins, enabling them to thrive in benthic environments. However, the molecular underpinnings of this unique trait remain unclear.*

*Here we investigate the origin of this phenotypic innovation by developing the little skate Leucoraja erinacea as a genomically enabled model.*

*Analysis of a high-quality chromosome-scale genome sequence for the little skate shows that it preserves many ancestral jawed vertebrate features compared with other sequenced genomes, including numerous ancient microchromosomes.*

*Combining genome comparisons with extensive regulatory datasets in developing fins, including gene expression, chromatin occupancy and three-dimensional conformation, we find skate-specific genomic rearrangements that alter the three-dimensional regulatory landscape of genes that are involved in the planar cell polarity pathway.*

*Functional inhibition of planar cell polarity signalling resulted in a reduction in anterior fin size, confirming that this pathway is a major contributor to batoid fin morphology.*

*We also identified a fin-specific enhancer that interacts with several hoxa genes, consistent with the redeployment of hox gene expression in anterior pectoral fins, and confirmed its potential to activate transcription in the anterior fin using zebrafish reporter assays.*

*Our findings underscore the central role of genome reorganization and regulatory variation in the evolution of phenotypes, shedding light on the molecular origin of an enigmatic trait.*

Riskin, D.K., and G.G. Carter (2023) **The evolution of sanguivory in vampire bats: origins and convergences.** CANADIAN JOURNAL OF ZOOLOGY 101:doi.org/10.1139/cjz-2022-0115

Authors’ abstract: *Blood-feeding (sanguivory) has evolved more than two dozen times among birds, fishes, insects, arachnids, molluscs, crustaceans, and annelids; however, among mammals, it is restricted to the vampire bats.*

*Here, the authors revisit the question of how it evolved in that group. Evidence to date suggests that the ancestors of phyllostomids were insectivorous, and that carnivory, omnivory, and nectarivory evolved among phyllostomids after vampire bats diverged.*

*Frugivory [fruit eating] likely also evolved after vampire bats diverged, but the phylogeny is ambiguous on that point. However, vampire bats lack any genetic evidence of a frugivorous past, and the behavioural progression from frugivory to sanguivory is difficult to envision.*

*Thus, the most parsimonious scenario is that sanguivory evolved in an insectivorous ancestor to vampire bats via ectoparasite-eating, wound-feeding, or some combination of the two, all feeding habits found among blood-feeding birds today.*

*Comparing vampire bats with other sanguiores, the authors find several remarkable examples of convergence. Further, it was found that blood-feeding has been circa 50 times more likely to evolve in a vertebrate lineage than in an invertebrate one.*

*The authors hypothesize that this difference exists because vertebrates are more likely than invertebrates to have the biochemical necessities required to assimilate the components of vertebrate blood.*

Kaufmann, L.V., et al (2023) **Elephant banana peeling.** CURRENT BIOLOGY 33:R239-R258 (available as a free pdf)

Authors’ extracts: *Here we describe the banana-peeling behavior of the female Asian elephant Pang Pha at the Berlin Zoo. Like other elephants, Pha consumes green or yellow bananas as a whole. She rejects brown bananas but, unlike other elephants, when on her own she peels yellow-brown bananas.*



*Pha peels faster than humans by a partially stereotyped sequence of behaviors: she breaks the banana, shakes out and collects the pulp, and discards the peel.*

*When yellow-brown bananas are offered to a group of elephants, she changes her behavior and consumes all bananas as a whole with exception of the last banana, which she retains for later peeling.*

*Banana peeling appears to be rare in elephants and none of the other Berlin elephants engage in peeling, raising the question why only Pha peels bananas.*

*Pha was handraised by human caretakers in the Berlin Zoo, who fed her peeled bananas, but never conditioned her to peel them. We suggest she acquired peeling through observational learning from humans.*

**Botany.**

Peppe, D. J., et al (2023) **Oldest evidence of abundant C<sub>4</sub> grasses and habitat heterogeneity in eastern Africa.** SCIENCE 380:doi.org/10.1126/science.abq2834

[There are three types of photosynthesis: C<sub>3</sub>, C<sub>4</sub>, and CAM. C<sub>3</sub> produces sugars with 3 carbon atoms as their basic building block, and is found in plants adapted to moist environments such as the tropics or temperate zones.]

[C<sub>4</sub> produces sugars with 4 carbon atoms and is found in plants adapted to seasonal drought or generally dry climates. The vast majority are grasses.]

[CAM is Crassulacean Acid Metabolism, found in desert plants and aquatic plants living in nutrient-poor waters. CAM recycles carbon atoms and enables plants to produce sugars where heat would fry them or where carbon is scarce.]

Authors’ abstract: *The assembly of Africa’s iconic C<sub>4</sub> grassland ecosystems is central to evolutionary interpretations of many mammal lineages, including hominins. C<sub>4</sub> grasses are thought to have become ecologically dominant in Africa only after 10 million years ago (Ma).*

*However, paleobotanical records older than 10 Ma are sparse, limiting assessment of the timing and nature of C<sub>4</sub> biomass expansion. This study uses a multiproxy design to document vegetation structure from nine Early Miocene*

*mammal site complexes across eastern Africa. Results demonstrate that between ~21 and 16 Ma, C<sub>4</sub> grasses were locally abundant, contributing to heterogeneous habitats ranging from forests to wooded grasslands.*

*These data push back the oldest evidence of C<sub>4</sub> grass-dominated habitats in Africa, and globally, by more than 10 million years, calling for revised paleoecological interpretations of mammalian evolution.*

Khait, I., et al (2023) **Sounds emitted by plants under stress are airborne and informative.** CELL 186:doi.org/10.1016/j.cell.2023.03.009 (available as a free pdf)

Authors’ abstract: *Stressed plants show altered phenotypes, including changes in color, smell, and shape. Yet, airborne sounds emitted by stressed plants have not been investigated before. Here we show that stressed plants emit airborne sounds that can be recorded from a distance and classified.*

*We recorded ultrasonic sounds emitted by tomato and tobacco plants inside an acoustic chamber, and in a greenhouse, while monitoring the plant’s physiological parameters.*

*We developed machine learning models that succeeded in identifying the condition of the plants, including dehydration level and injury, based solely on the emitted sounds. These informative sounds may also be detectable by other organisms.*

**Environmental Science.**

Guillet, S., et al (2023) **Lunar eclipses illuminate timing and climate impact of medieval volcanism.** NATURE 616:doi.org/10.1038/s41586-023-05751-z (available as a free pdf)

Authors’ abstract: *Explosive volcanism is a key contributor to climate variability on interannual to centennial timescales. Understanding the far-field societal impacts of eruption forced climatic changes requires firm event chronologies and reliable estimates of both the burden and altitude (that is, tropospheric versus stratospheric) of volcanic sulfate aerosol.*

*However, despite progress in ice-core dating, uncertainties remain in these key factors. This particularly hinders investigation of the role of large, temporally clustered eruptions during the High Medieval Period (HMP, 1100 to 1300 CE), which have been implicated in the transition from the warm Medieval Climate Anomaly to the Little Ice Age.*

*Here we shed new light on explosive volcanism during the HMP, drawing on analysis of contemporary reports of total lunar eclipses, from which we derive a time series of stratospheric turbidity.*

*By combining this new record with aerosol model simulations and tree-ring-based climate proxies, we refine the estimated dates of five notable eruptions and associate each with stratospheric aerosol veils.*

*Five further eruptions, including one responsible for high sulfur deposition over Greenland circa 1182 CE, affected only the troposphere and had muted climatic consequences. Our findings offer support for further investigation of the decadal scale to centennial-scale climate response to volcanic eruptions.*

*Large explosive volcanic eruptions can inject enormous quantities of sulfur-bearing gases into the stratosphere, where they generate sulfate aerosols.*

*The resulting aerosol veils perturb the energy budget of the Earth, inducing seasonal and regional surface temperature and precipitation anomalies, whose severity in combination with societal vulnerabilities has been linked to historical cases of agronomic and pasturage deficits, civil and political unrest, pestilence and migration.*

*Although the geologic record constitutes the primary evidence of past volcanism, with chronologies based on radiocarbon and other radiometric methods, polar ice cores arguably furnish the most comprehensive and accessible picture of climatically notable volcanism through the compilation of sulfur deposition time series.*

*Of particular note in such records is a proliferation of sulfur-rich eruptions during the HMP (circa twelfth and thirteenth centuries), beginning with a cluster of events around 1108 to 1110 CE and including the colossal Samalas eruption around 1257 CE.*

*These events have been linked with substantial cooling and subsistence crises and the combined effect of their forcing has been posited as a contributor to the onset of the Little Ice Age.*

*The rare and often visually spectacular atmospheric optical phenomena that can arise from the presence of volcanic dust veils in the stratosphere, such as solar dimming, coronae or Bishop's rings, peculiar twilight coloration and dark total lunar eclipses, have long been regarded as portents worth recording.*

*References to such phenomena have provided independent evidence to evaluate the timing and impact of volcanism for the periods 1500 BCE to 1000 CE, 1500 to 1880 CE and 1880 to 2000 CE.*

Zhao, S., et al (2023) **Pelagic microplastics in the North Pacific Subtropical Gyre: A prevalent anthropogenic component of the particulate organic carbon pool.** PNAS NEXUS 2:doi.org/10.1093/pnasnexus/pgad070 (available as a free pdf)

Authors' abstract: *The overall ubiquity and abundance of microplastics in the world's ocean make them an emerging constituent of the marine carbon pool. However, little is known about the dynamics of microplastics from the surface to the deep ocean.*

*Here we present in situ evidence of microplastic particles throughout the water column of the North Pacific Garbage Patch located in the eastern North Pacific Subtropical Gyre, based on field-based measurements of their concentrations and chemical and physical properties.*

*Our results imply that the biological carbon pump is a major contributor to the redistribution of microplastics in the ocean. Due to its ever-increasing ocean inputs, fossil-based microplastics comprise a considerable constituent in the particulate organic carbon pool, which is instrumental in ocean biogeochemical cycling.*

*Here we show that microplastics prevail throughout the water column of the eastern North Pacific Subtropical Gyre, comprising 334 #/m<sup>3</sup> (84.5% of plastic particles <100 μm), with exponential relationships between concentrations and water depth in the upper 500-m layer and marked accumulation below this layer.*



*Our results suggest that the biological carbon pump strongly contributes to the water column microplastics redistribution in terms of polymer type, material density and particle size, which in turn could influence the efficiency of organic matter export to the deep sea.*

*We further show that <sup>14</sup>C-depleted plastic particles predictably are an emerging non-neglectable perturbation to radiocarbon signatures in the deep ocean through depletion of the <sup>14</sup>C/C ratio in the particulate organic carbon pool.*

*Our data provide insight into vertical microplastics flux and highlight the potential role of microplastics in alternating the marine particulate pool and interactions with the biological carbon pump.*

Speirs: Note that penultimate paragraph. Microplastics can throw off radiocarbon dating because of their artificially depleted carbon ratio.

Wang, J., et al (2023) **Soil moisture observations from shortwave infrared channels reveal tornado tracks: A case in 10-11 December 2021 tornado outbreak.** GEOPHYSICAL RESEARCH LETTERS 50:doi.org/10.1029/2023GL102984 (available as a free pdf)

Authors’ abstract: *Satellite-based post-tornado assessments have been widely used for the detection of tornado tracks, which heavily relies on the identification of vegetation changes through observations at visible and near-infrared channels.*

*During the deadly 10 and 11 December 2021 tornado outbreak, a series of violent tornadoes first touched down over northeastern Arkansas, an area dominated by cropland with rare vegetation coverage in winter.*

*Through the examination of Moderate Resolution Imaging Spectroradiometer multi-spectral observations, this study reveals significant scars on shortwave infrared channels over this region, but none are captured by visible and near-infrared channels.*

*The dominant soil type is aquert (one of vertisols), whose high clay content well preserves the severe changes in soil structure during the tornado passage, when the topmost soil layer was removed and underlying soil with higher moisture content was exposed to the air.*

[Image is from this paper and shows the tornado track at Caruthersville, Missouri.]



Magioli, M., et al (2023) **Plasticity in resource use explains the persistence of the largest living rodent in anthropized environments.** JOURNAL OF ZOOLOGY 319:10.1111/jzo.13057 (available as a free pdf)

[C<sub>3</sub> plants are those that live in a reasonably moist environment, such as trees, shrubs, and herbs. C<sub>4</sub> plants are grasses and dryland plants.]

Authors' abstract: *Here, we show the resource use plasticity of capybaras (Hydrochoerus hydrochaeris), the largest living rodent, in natural and anthropized environments of Brazil using stable carbon and nitrogen isotopes in hair.*

*We assessed the resource use, size and overlap of isotopic niches, and the influence of body mass, age class, sex, and landscape composition on isotopic values among 13 capybara populations (210 individuals).*

*We observed a wide variation in isotopic values of capybaras among and within populations in different environments. Surprisingly, diets varied from strictly C<sub>4</sub>-based to strictly C<sub>3</sub>-based, with most individuals feeding on C<sub>4</sub> plants (65%).*

*A substantial portion of individuals presented mixed diets (C<sub>3</sub> and C<sub>4</sub> plants), totaling 31% of the individuals, and few fed exclusively on C<sub>3</sub> plants (4%). Isotopic niche size also varied among populations in both environments, with low overlap considering their core dietary niche.*

*Capybara populations in natural environments had substantial incorporation of C<sub>3</sub> resources, showing individuals with strictly C<sub>3</sub> diets, and possibly relying on a high diversity of food items, while some populations in anthropized ones fed exclusively on C<sub>4</sub> resources.*

*Neither body mass, age class, sex, nor landscape composition significantly influenced isotopic values. Here, we provide evidence of the dietary plasticity of capybaras in different environments, transitioning from the consumption of C<sub>4</sub> to C<sub>3</sub> plants when needed, that is, from preferred to non-preferred food items.*

*Together with the species' behavioral plasticity, our results help explain its resilience in surviving, and even thriving, in both natural and human-modified environments.*

Pope, N.S., et al (2023) **The expansion of agriculture has shaped the recent evolutionary history of a specialized squash pollinator.** PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCE USA 120:doi.org/10.1073/pnas.2208116120 (available as a free pdf)

Authors' abstract: *The expansion of agriculture is responsible for the mass conversion of biologically diverse natural environments into managed agroecosystems dominated by a handful of genetically homogeneous crop species.*

*Agricultural ecosystems typically have very different abiotic and ecological conditions from those they replaced and create potential niches for those species that are able to exploit the abundant resources offered by crop plants.*

*While there are well-studied examples of crop pests that have adapted into novel agricultural niches, the impact of agricultural intensification on the evolution of crop mutualists such as pollinators is poorly understood.*

*We combined genealogical inference from genomic data with archaeological records to demonstrate that the Holocene demographic history of a wild specialist pollinator of Cucurbita (pumpkins, squashes, and gourds) has been profoundly impacted by the history of agricultural expansion in North America.*

*Populations of the squash bee Eucera pruinosa experienced rapid growth in areas where agriculture intensified within the past 1,000 years, suggesting that the cultivation of Cucurbita in North America has increased the amount of floral resources available to these bees.*

*In addition, we found that roughly 20% of this bee species' genome shows signatures of recent selective sweeps.*

*These signatures are overwhelmingly concentrated in populations from eastern North America where squash bees were historically able to colonize novel environments due to human cultivation of Cucurbita pepo and now exclusively inhabit agricultural niches.*

*These results suggest that the widespread cultivation of crops can prompt adaptation in wild pollinators through the distinct ecological conditions imposed by agricultural environments.*



**Geology.**

Gabrovsek, F. (2023) **How do caves breathe: The airflow patterns in karst underground.** PLOS ONE 18:doi.org/10.1371/journal.pone.0283767

Author’s abstract: *Caves and their surrounding fracture systems in the vadose zone of karst regions host a unique atmospheric environment. Understanding the airflow patterns in caves is critical to understanding the properties of the subsurface atmosphere and the chemical interactions between air, water, and rock.*

*The most common driver of airflow in caves is the density difference between the subsurface and the outside air, known as the chimney effect. Observations show that seasonal airflow patterns in caves also depend on the geometry of passages.*

*In this work, I present and use a numerical model of a passage embedded and thermally coupled to a rock mass to study the relationship between the airflow pattern and passage geometry.*

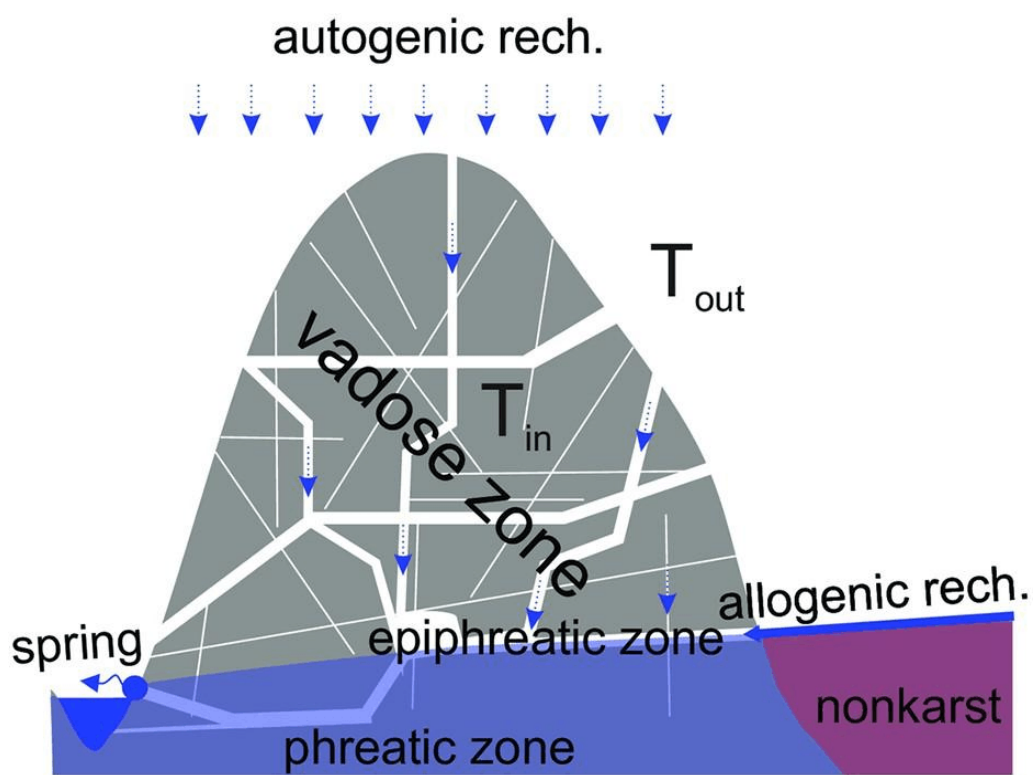
*As the outside air enters the subsurface, it approaches thermal equilibrium with the rock mass along a characteristic relaxation length. This determines the temperature and density contrast between the inside and outside air, and the resulting pressure difference, which drives the airflow.*

*In passages with non-uniform outlines and/or cross-sections, the relaxation length may depend on the flow direction, resulting in different airflow velocities in cold and warm periods for the same absolute temperature difference between the massif and the external temperature.*

*In a passage with a V-shaped longitudinal profile, the airflow is triggered by instability which causes the feedback between the relaxation length and airflow velocity.*

*The airflow pattern can also be altered by snow and ice. Heat transfer in the rock and the thermal inertia of the rock also change the relaxation lengths and cause hysteresis in the curve presenting the airflow velocity vs. temperature difference.*

[Image is from this paper.]



Lasser, J., et al (2023) **Salt polygons and porous media convection.** PHYSICAL REVIEW X 13:doi.org/10.1103/PhysRevX.13.011025 (available as a free pdf)

Authors’ abstract: *Here, we investigate the origins of polygonally patterned crusts of salt playa and salt pans. These beautifully regular features, approximately a meter in diameter, are found worldwide and are fundamentally important to the transport of salt and dust in arid regions.*

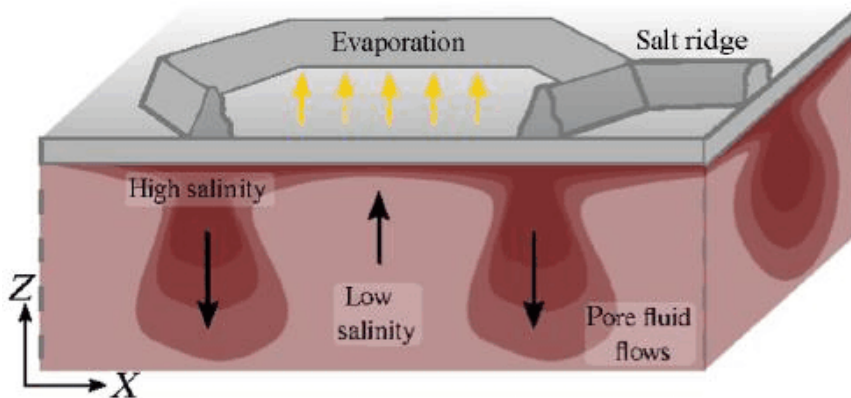
*We show that they are consistent with the surface expression of buoyancy-driven convection in the porous soil beneath a salt crust. By combining quantitative results from direct field observations, analog experiments, and numerical simulations, we further determine the conditions under which salt polygons should form, as well as how their characteristic size emerges.*

Variously referred to as salt pans, playas, or dry lakes, the immediately prominent feature of such landscapes is a characteristic tiling of polygons formed by ridges in the salt-encrusted surface.

These patterns are seen around the world, including Salar de Uyuni in Chile, Chott el Djerid in Tunisia, Badwater Basin in California, Dasht-e Kavir in Iran, and Dalangtan Playa in China.

Although they have been argued to share similarities with fracture or buckling patterns, a quantitative and predictive mechanism for the emergence of the patterns remains obscure.

[Images are from this paper.]



Keller, L.M., et al (2023) **An active microbiome in Old Faithful geyser.** PNAS NEXUS 2:doi.org/10.1093/pnasnexus/pgad066 (available as a free pdf)

Authors' abstract: Geysers, like hot springs, contain all components necessary for life, including water (liquid and steam), CO<sub>2</sub>, and chemical disequilibria.

Here, we show that geysed waters from Old Faithful Geyser in Yellowstone National Park contain an active microbiome founded on autotrophy and chemical energy.

Genomic data suggest a role for geyser dynamics in generating and/or maintaining genomic biodiversity. These findings further our understanding of the habitability of geysers and showcase potential approaches to detect life in similar systems on other planetary bodies.

Natural thermal geysers are hot springs that periodically erupt liquid water, steam, and gas. They are found in only a few locations worldwide, with nearly half located in Yellowstone National Park.

Old Faithful Geyser is the most iconic in Yellowstone National Park and attracts millions of visitors annually. Despite extensive geophysical and hydrological study of geysers, including Old Faithful Geyser, far less is known of the microbiology of geysed waters.

Here, we report geochemical and microbiological data from geysed vent water and vent water that collects in a splash pool adjacent to Old Faithful Geyser during eruptions. Both waters contained microbial cells, and radiotracer studies showed that they fixed carbon dioxide (CO<sub>2</sub>) when incubated at 70°C and 90°C.

Shorter lag times in CO<sub>2</sub> fixation activity were observed in vent and splash pool waters incubated at 90°C than 70°C, suggesting cells are better adapted or acclimated to temperatures like those in the Old Faithful Geyser vent (~92 to 93°C).

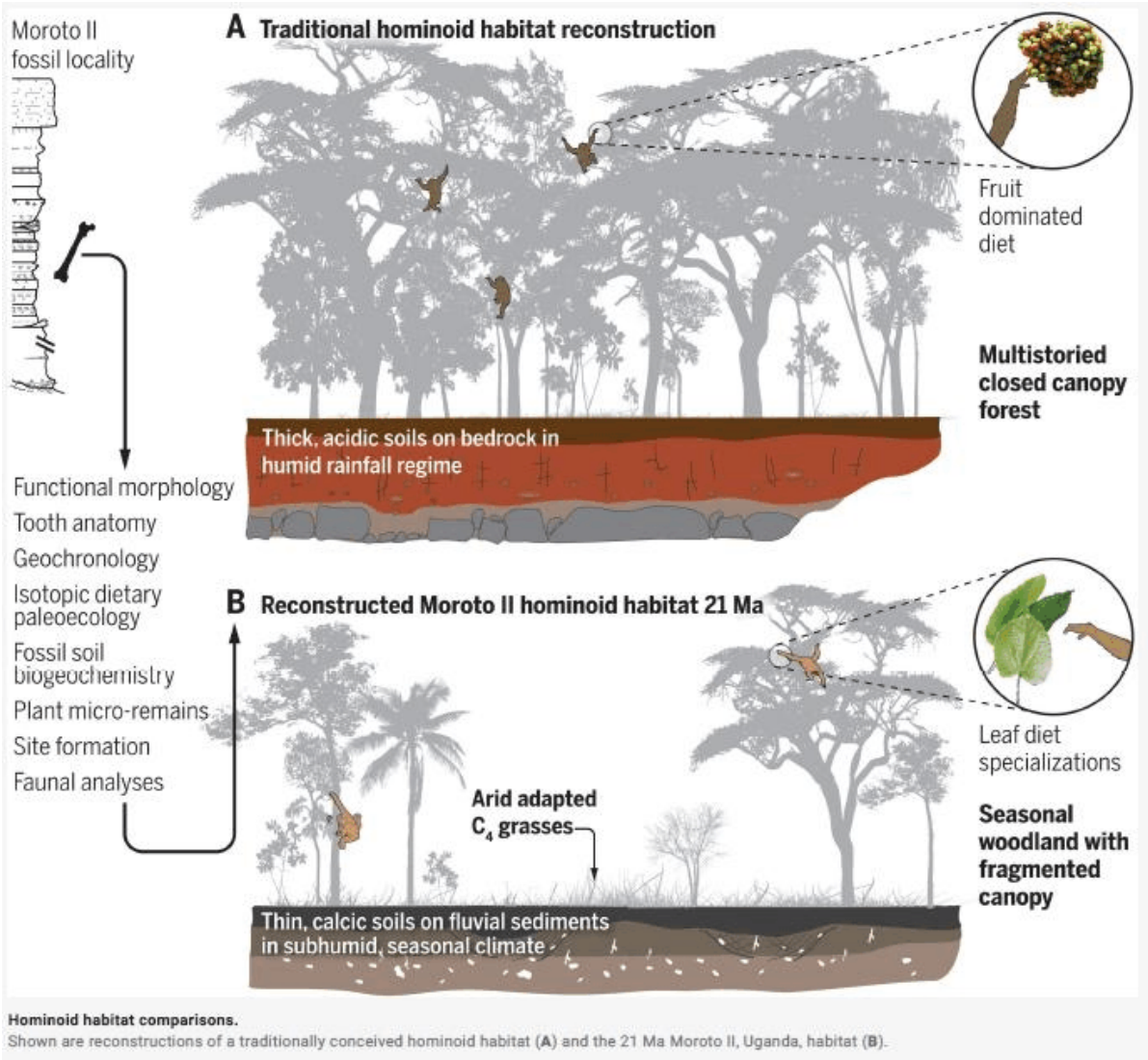
16S rDNA and metagenomic sequence data indicated that both communities are dominated by the autotroph *Thermocrinis*, which likely fuels productivity through the aerobic oxidation of sulfide/thiosulfate in erupted waters or steam.



*Dominant Old Faithful Geyser populations, including Thermocrinis and subdominant Thermus and Pyrobaculum strains, exhibited high-strain level genomic diversity (putative ecotypes) relative to populations from nongeysing Yellowstone National Park hot springs that is attributed to the temporal chemical and temperature dynamics caused by eruptions.*

*These findings show that Old Faithful Geyser is habitable and that its eruption dynamics promote genomic diversity, while highlighting the need to further research the extent of life in geyser systems such as Old Faithful Geyser.*

**Human Prehistory.**



MacLatchy, L.M., et al (2023) **The evolution of hominoid locomotor versatility: Evidence from Moroto, a 21 Ma site in Uganda.** SCIENCE 380:doi.org/10.1126/science.abq2835

Authors’ abstract: *Inherent in traditional views of ape origins is the idea that, like living apes, early large-bodied apes lived in tropical forests.*

*In response to constraints related to locomoting in forest canopies, it has been proposed that early apes evolved their quintessential upright torsos and acrobatic climbing and suspensory abilities, enhancing their locomotor versatility, to distribute their weight among small supports and thus reach ripe fruit in the terminal branches.*

*This feeding and locomotor transition from a quadruped with a horizontal torso is thought to have occurred in the Middle Miocene due to an increasingly seasonal climate and feeding competition from evolving monkeys.*

*Although ecological and behavioral comparisons among living apes and monkeys provide evidence for versions of terminal branch forest frugivory hypotheses, corroboration from the early ape fossil record has been lacking, as have detailed reconstructions of the habitats where the first apes evolved.*

*The Early Miocene fossil site of Moroto II in Uganda provides a unique opportunity to test the predictions of terminal branch forest frugivory hypotheses.*

*Moroto II documents the oldest [21 million years ago (Ma)] well-established paleontological record of ape teeth and postcranial bones from a single locality and preserves paleoecological proxies to reconstruct the environment.*

*A short, strong femur biomechanically favorable to vertical climbing and a vertebra indicating a dorsostable lower back confirm that ape fossils from Moroto II shared locomotor traits with living apes.*

*Both Morotopithecus and a smaller ape from the site have elongated molars with well-developed crests for shearing leaves. Carbon isotopic signatures of the enamel of these apes and of other fossil*

*mammals indicate that some mammals consistently fed on water-stressed C<sub>3</sub> plants, and possibly also C<sub>4</sub> vegetation, in a woodland setting.*

*Carbon isotope values of pedogenic carbonates, paleosol organic matter, and plant waxes all point to substantial C<sub>4</sub> grass biomass on the landscape.*

*Analysis of paleosols also indicates subhumid, strongly seasonal rainfall, and phytolith assemblages include forms from both arid adapted C<sub>4</sub> grasses and forest-indicator plants.*

*The ancient co-occurrence of dental specializations for leaf eating, rather than ripe fruit consumption, along with apelike locomotor abilities counters the predictions of the terminal branch forest frugivory hypotheses.*

*The combined paleoecological evidence situates Morotopithecus in a woodland with a broken canopy and substantial grass understory including C<sub>4</sub> species.*

*These findings call for a new paradigm for the evolutionary origins of early apes. We propose that seasonal, wooded environments may have exerted previously unrecognized selective pressures in the evolution of arboreal apes.*

*For example, some apes may have needed to access leaves in the higher canopy in times of low fruit availability and to be adept at ascending and descending from trees that lacked a continuous canopy.*

[Images are from this paper.]

Wojcieszak, M., et al (2023) **Evidence for large land snail cooking and consumption at Border Cave c. 170–70 ka ago. Implications for the evolution of human diet and social behaviour.** QUATERNARY SCIENCE REVIEWS 306:doi.org/10.1016/j.quascirev.2023.108030

Authors' abstract: *Fragments of land snail (Achatinidae) shell were found at Border Cave [South Africa] in varying proportions in all archaeological members, with the exception of the oldest members 5 WA and 6 BS (>227,000 years ago).*

*They were recovered in relatively high frequencies in Members 4 WA, 4 BS, 1 RGS and 3 WA. The shell fragments present a range of colours from lustrous*

*beige to brown and matt grey. The colour variability can occur when shell is heated.*

*This possibility was explored here through experimental heating of giant land snail shell fragments (Achatinidae, Metachatina kraussi - brown lipped agate snail) in a muffle furnace from 200 to 550 °C for different lengths of time. Colour change, weight loss, and shattering of the heated samples were recorded.*

*Transformation of aragonite into calcite and the occurrence of organic material was investigated by means of Infrared and Raman spectroscopy. Scanning electron microscopy was also used on selected specimens to help identify heat-induced transformation as opposed to taphonomic alteration.*

*The identification on archaeological fragments of features produced by experimentally heating shells at high temperatures or for long periods has led us, after discarding alternative hypotheses, to conclude that large African land snails were systematically brought to the site by humans, roasted and consumed, starting from 170,000 years ago and, more intensively between 160,000 and 70,000 years ago.*

*Border Cave is at present the earliest known site at which this subsistence strategy is recorded. Previous research has shown that charred whole rhizomes and fragments of edible Hypoxis angustifolia were also brought to Border Cave to be roasted and shared at the site.*

*Thus, evidence from both the rhizomes and snails in Border Cave supports an interpretation of members of the group provisioning others at a home base, which gives us a glimpse into the complex social life of early Homo sapiens.*

Villalba-Mouco, V., et al (2023) **A 23,000-year-old southern Iberian individual links human groups that lived in Western Europe before and after the Last Glacial Maximum.** NATURE ECOLOGY AND EVOLUTION 7:doi.org/10.1038/s41559-023-01987-Article-0 (available as a free pdf)

Authors' abstract: *Human populations underwent range contractions during the Last Glacial Maximum (LGM) which had lasting and dramatic effects on their genetic variation.*



*The genetic ancestry of individuals associated with the post-LGM Magdalenian technocomplex has been interpreted as being derived from groups associated with the pre-LGM Aurignacian. However, both these ancestries differ from that of central European individuals associated with the chronologically intermediate Gravettian.*

*Thus, the genomic transition from pre- to post-LGM remains unclear also in western Europe, where we lack genomic data associated with the intermediate Solutrean, which spans the height of the LGM.*

*Here we present genome-wide data from sites in Andalusia in southern Spain, including from a Solutrean-associated individual from Cueva del Malalmuerzo, directly dated to ~23,000 calendar years ago.*

*The Malalmuerzo individual carried genetic ancestry that directly connects earlier Aurignacian-associated individuals with post-LGM Magdalenian-associated ancestry in western Europe.*

*This scenario differs from Italy, where individuals associated with the transition from pre- and post-LGM carry different genetic ancestries. This suggests different dynamics in the proposed southern refugia of Ice Age Europe and posits Iberia as a potential refugium for western European pre-LGM ancestry.*

*More, individuals from Cueva Ardales, which were thought to be of Palaeolithic origin, date younger than expected and, together with individuals from the Andalusian sites Caserones and Aguilillas, fall within the genetic variation of the Neolithic, Chalcolithic and Bronze Age individuals from southern Iberia.*

*The peopling of Europe was marked by human population expansions and contractions associated with major climatic events. Numerous studies indicate a dramatic population contraction in Palaeolithic Europe during the Last Glacial Maximum (LGM, ~26.6 to 19 kiloyears ago).*

*Human presence in the archaeological record is documented predominantly by artifacts, mainly stone tools assigned to so-called technocomplexes, rather than by skeletal remains, which are rare in the Palaeolithic record.*

Davy, T., et al (2023) **Hunter-gatherer admixture facilitated natural selection in Neolithic European farmers.** CURRENT BIOLOGY 33:1365-1371 (available as a free pdf)

*Authors' abstract: Ancient DNA has revealed multiple episodes of admixture in human prehistory during geographic expansions associated with cultural innovations. One important example is the expansion of Neolithic agricultural groups out of the Near East into Europe and their consequent admixture with Mesolithic hunter-gatherers.*

*Ancient genomes from this period provide an opportunity to study the role of admixture in providing new genetic variation for selection to act upon, and also to identify genomic regions that resisted hunter-gatherer introgression and may thus have contributed to agricultural adaptations.*

*We used genome-wide DNA from 677 individuals spanning Mesolithic and Neolithic Europe to infer ancestry deviations in the genomes of admixed individuals and to test for natural selection after admixture by testing for deviations from a genome-wide null distribution.*

*We find that the region around the pigmentation-associated gene SLC24A5 shows the greatest overrepresentation of Neolithic local ancestry in the genome.*

*In contrast, we find the greatest overrepresentation of Mesolithic ancestry across the major histocompatibility complex, a major immunity locus, which also shows allele frequency deviations indicative of selection following admixture.*

*This could reflect negative frequency-dependent selection on MHC alleles common in Neolithic populations or that Mesolithic alleles were positively selected for and facilitated adaptation in Neolithic populations to pathogens or other environmental factors.*

Taylor, W.T.T., et al (2023) **Early dispersal of domestic horses into the Great Plains and northern Rockies.** SCIENCE 379:1316-1323 (available as a free pdf)

*Authors' abstract: The horse is central to many Indigenous cultures across the American Southwest and the Great Plains. However, when and how horses*

*were first integrated into Indigenous lifeways remain contentious, with extant models derived largely from colonial records.*

*We conducted an interdisciplinary study of an assemblage of historic archaeological horse remains, integrating genomic, isotopic, radiocarbon, and paleopathological evidence.*

*Archaeological and modern North American horses show strong Iberian genetic affinities, with later influx from British sources, but no Viking proximity.*

*Horses rapidly spread from the south into the northern Rockies and central plains by the first half of the 17th century CE, likely through Indigenous exchange networks.*

*They were deeply integrated into Indigenous societies before the arrival of 18th-century European observers, as reflected in herd management, ceremonial practices, and culture.*

**Tang, L., et al (2023) Paleoproteomic evidence reveals dairying supported prehistoric occupation of the highland Tibetan Plateau. SCIENCE ADVANCES 9:doi.org/10.1126/sciadv.adf0345 (available as a free pdf)**

*Authors' abstract: The extreme environments of the Tibetan Plateau offer considerable challenges to human survival, demanding novel adaptations.*

*While the role of biological and agricultural adaptations in enabling early human colonization of the plateau has been widely discussed, the contribution of pastoralism is less well understood, especially the dairy pastoralism that has historically been central to Tibetan diets.*

*Here, we analyze ancient proteins from the dental calculus (n = 40) of all human individuals with sufficient calculus preservation from the interior plateau.*

*Our paleoproteomic results demonstrate that dairy pastoralism began on the highland plateau by ~3500 years ago. Patterns of milk protein recovery point to the importance of dairy for individuals who lived in agriculturally poor regions above 3700 metres above sea level.*

*Our study suggests that dairy was a critical cultural adaptation that supported expansion of early pastoralists into the region's vast, non-arable highlands, opening the Tibetan Plateau up to widespread, permanent human occupation.*

**Modern Humans.**

**Zhao, J., et al (2023) Association between daily alcohol intake and risk of all-cause mortality: A systematic review and meta-analyses. JAMA Network Open 6:doi.org/10.1001/jamanetworkopen.2023.6185 (available as a free pdf)**

*Authors' abstract: In fully adjusted, prespecified models that accounted for effects of sampling, between-study variation, and potential confounding from former drinker bias and other study-level covariates, our meta-analysis of 107 studies found*

- (1) no significant protective associations of occasional or low-volume drinking (moderate drinking) with all-cause mortality; and*
- (2) an increased risk of all-cause mortality for drinkers who drank 25 grams or more and a significantly increased risk when drinking 45 grams or more per day.*

*This systematic review and meta-analysis of 107 cohort studies involving more than 4.8 million participants found no significant reductions in risk of all-cause mortality for drinkers who drank less than 25 grams of ethanol per day (about two Canadian standard drinks compared with lifetime nondrinkers) after adjustment for key study characteristics such as median age and sex of study cohorts.*

*There was a significantly increased risk of all-cause mortality among female drinkers who drank 25 or more grams per day and among male drinkers who drank 45 or more grams per day. Low-volume alcohol drinking was not associated with protection against death from all causes.*



Chang, H.C.H., et al (2023) **Complex systems of secrecy: the offshore networks of oligarchs.** PNAS NEXUS 2:doi.org/10.1093/pnasnexus/pgad051 (available as a free pdf)

Authors’ abstract: *Following the invasion of Ukraine, the USA, UK, and EU governments—among others—sanctioned oligarchs close to Putin. This approach has come under scrutiny, as evidence has emerged of the oligarchs’ successful evasion of these punishments.*

*To address this problem, we analyze the role of an overlooked but highly influential group: the secretive professional intermediaries who create and administer the oligarchs’ offshore financial empires.*

*Drawing on the Offshore Leaks Database provided by the International Consortium of Investigative Journalists (ICIJ), we examine the ties linking offshore expert advisors (lawyers, accountants, and other wealth management professionals) to ultra-high-net-worth individuals from four countries: Russia, China, the USA, and Hong Kong.*

*We find that resulting nation-level “oligarch networks” share a scale-free structure characterized by a heterogeneity of heavy-tailed degree distributions of wealth managers; however, network topologies diverge across clients from democratic versus autocratic regimes.*

*While generally robust, scale-free networks are fragile when targeted by attacks on highly connected nodes. Our “knock-out” experiments pinpoint this vulnerability to the small group of wealth managers themselves, suggesting that sanctioning these professional intermediaries may be more effective and efficient in disrupting dark finance flows than sanctions on their wealthy clients.*

*This vulnerability is especially pronounced amongst Russian oligarchs, who concentrate their offshore business in a handful of boutique wealth management firms. The distinctive patterns we identify suggest a new approach to sanctions, focused on expert intermediaries to disrupt the finances and alliances of their wealthy clients.*

**Technology.**

Liu, M., et al (2023) **Flying cars economically favor battery electric over fuel cell and internal combustion engine.** PNAS NEXUS 2:doi.org/10.1093/pnasnexus/pgad019 (available as a free pdf)

Authors’ abstract: *Flying cars, essentially vertical takeoff and landing aircraft (VTOL), are an emerging, disruptive technology that is expected to reshape future transportation. VTOLs can be powered by battery electric, fuel cell, or internal combustion engine, which point to entirely different needs for industry expertise, research & development, supply chain, and infrastructure supports.*

*A pre-analysis of the propulsion technology competition is crucial to avoid potential wrong directions of research, investment, and policy making efforts. In this study, we comprehensively examined the cost competitiveness of the three propulsion technologies.*

*Here we show that battery electric has already become the lowest-cost option for below-200-km VTOL applications, covering intra-city and short-range inter-city travels. This cost advantage can be robustly strengthened in the long term under various technology development scenarios.*

*Battery energy density improvement is the key to reducing cost. In particular, a 600 Wh/kg battery energy density provides battery electric with all-range cost advantage, and promises high return in business.*

*Fuel cell and internal combustion engine, under certain technology development scenarios, can obtain cost advantage in long-range applications, but face intense competition from ground transportation such as high-speed rail.*

*The findings suggest a battery-electric-prioritized VTOL development strategy, and the necessity of developing VTOL-customized high-energy-density batteries.*

van Erp, M., et al (2023) **More than the Name of the Rose: How to make computers read, see, and organize smells.** AMERICAN HISTORICAL REVIEW 128:doi.org/10.1093/ahr/rhad141 (available as a free pdf)

Authors’ extracts: *The aim of the project is to develop a “computer nose”: design AI strategies to capture references to smells in the past from digital heritage collections.*

*In this article, we will provide a step-by-step explanation on how Odeuropa employs language and computer vision technology to extract smell-related information from texts and images, and how these extracted bits of information are then encoded in a so-called knowledge graph, a graph-like database built on Semantic Web technologies (the European Olfactory Knowledge Graph, or EOKG).*

*From here, we can extract storylines and follow smell sources (such as roses), noses, and olfactory practices over time and space.*

*In Odeuropa we focus on what we call “olfactory events”: explicit mentions of smells. So we do not capture all roses (e.g., a rose mentioned in a word list or recipe), but only the roses that appear around explicit smell words (e.g. smell, sniff, stink, perfume).*

*To capture these events, we extract text snippets around smell words and smell sources, and we identify the qualities used to describe them. We also try to analyze when and where the smell event took place.*

*This, along with metadata of the documents such as the genre, the author, and the date and place of publication, can provide an extended representation of how smells and their perception changed over the course of time.*

*By further extending the extraction to multiple languages, we can potentially study which and how smells are perceived in different countries.*

Goel, V., et al (2023) **Hatemongers ride on echo chambers to escalate hate speech diffusion.** PNAS NEXUS 2:doi.org/10.1093/pnasnexus/pgad041 (available as a free pdf)

[This is how the wokers run amok.]

Authors’ abstract: *This work investigates the spread of online hate speech through the lens of information propagation, user engagement, and polarized consumption/production of information via echo chambers.*

*Our findings establish that hatemongers are way more potent to control the information dissemination over online social networks, even with apparently non-hateful introductions, compared to singled-out hateful posts.*

*This is largely due to such users acquiring a well-connected position on these networks through cohesive engagement with other hateful actors. Unlike merely organized activities, we find that this cohesion among hatemongers is realized via echo chamber formation.*

*We show that the amplified potential of hatemongers to popularize content is controlled via their echo chamber memberships.*

*Recent years have witnessed a swelling rise of hateful and abusive content over online social networks. While detection and moderation of hate speech have been the early go-to countermeasures, the solution requires a deeper exploration of the dynamics of hate generation and propagation.*

*We analyze more than 32 million posts from over 6.8 million users across three popular online social networks to investigate the interrelations between hateful behavior, information dissemination, and polarized organization mediated by echo chambers.*

*We find that hatemongers play a more crucial role in governing the spread of information compared to singled-out hateful content. This observation holds for both the growth of information cascades as well as the conglomeration of hateful actors.*

*Dissection of the core-wise distribution of these networks points towards the fact that hateful users acquire a more well-connected position in the social network and often flock together to build up information cascades.*



*We observe that this cohesion is far from mere organized behavior; instead, in these networks, hatemongers dominate the echo chambers, groups of users actively align themselves to specific ideological positions.*

*The observed dominance of hateful users to inflate information cascades is primarily via user interactions amplified within these echo chambers.*

*We conclude our study with a cautionary note that popularity-based recommendation of content is susceptible to be exploited by hatemongers given their potential to escalate content popularity via echo-chambered interactions.*

Bond, R.M., and R.K. Garrett (2023) **Engagement with fact-checked posts on Reddit**. PNAS NEXUS 2:doi.org/10.1093/pnasnexus/pgad018 (available as a free pdf)

*Authors’ abstract: False stories shared on Twitter diffuse more rapidly and widely than true stories. However, whether this pattern holds across other social media platforms is an open question.*

*Here, we investigate user engagement with posts eliciting fact-checking comments on Reddit. In contrast to prior work, we find that posts eliciting comments that include fact-checks indicating the information is true tend to receive more engagement across a variety of metrics than do posts eliciting comments that include fact-checks indicating the information is false.*

*This result is consistent with the interpretation that there are important platform-level differences in how message veracity influences engagement and diffusion.*

*Contested factual claims shared online are of increasing interest to scholars and the public. Characterizing temporal patterns of sharing and engagement with such information, as well as the effect of sharing associated fact-checks, can help us understand the online political news environment more fully.*

*Here, we investigate differential engagement with fact-checked posts shared online via Reddit from 2016 to 2018. The data comprise ~29,000 conversations, ~849,000 users, and ~9.8 million comments. We classified the veracity of the posts being discussed as true, mixed, or false using three fact-checking organizations.*

*Regardless of veracity, fact-checked posts had larger and longer lasting conversations than claims that were not fact-checked. Among those that were fact-checked, posts rated as false were discussed less and for shorter periods of time than claims that were rated as true.*

*We also observe that fact-checks of posts rated as false tend to happen more quickly than fact-checks of posts rated as true. Finally, we observe that thread deletion and removal are systematically related to the presence of a fact-check and the veracity of the fact-check, but when deletion and removal are combined the differences are minimal.*

**FREE STUFF ONLINE**

You will have noticed that I provide sources for the pdfs and mp3s reviewed in this zine. Here is a summary of some good resources, all of which are free.

In particular, the “Seen In The Literature” column cites only peer-reviewed papers. For topics such as climate change or social media effects, more people should be reading these papers instead of blogs where commentators confuse their opinions as being facts.

For scientific papers for which free pdfs are available, the easiest method is to Google either the title of the paper or its digital object identifier, the phrase beginning with doi.org.

Most papers are behind a paywall, so unless you have access to a university library computer, you can only get the abstract. However, the abstract is often enough to understand the gist of the article.

Every scientific periodical has free email notifications of each new issue’s table of contents. I subscribe to dozens of notification services, in case you were wondering how I manage to keep up with the literature.