

## References

### Afrika

MACKAY 2014

Alex Mackay, Brian A. Stewart & Brian M. Chase, *Coalescence and fragmentation in the late Pleistocene archaeology of southernmost Africa*. [Journal of Human Evolution](#) **72** (2014), 26–51.

The later Pleistocene archaeological record of southernmost Africa encompasses several Middle Stone Age industries and the transition to the Later Stone Age. Through this period various signs of complex human behaviour appear episodically, including elaborate lithic technologies, osseous technologies, ornaments, motifs and abstract designs. Here we explore the regional archaeological record using different components of lithic technological systems to track the transmission of cultural information and the extent of population interaction within and between different climatic regions. The data suggest a complex set of coalescent and fragmented relationships between populations in different climate regions through the late Pleistocene, with maximum interaction (coalescence) during MIS 4 and MIS 2, and fragmentation during MIS 5 and MIS 3. Coalescent phases correlate with increases in the frequency of ornaments and other forms of symbolic expression, leading us to suggest that population interaction was a significant driver in their appearance.

**Keywords:** Lithic technology | Middle and Later Stone Age | Still Bay | Howiesons Poort | Ornaments | Cultural transmission

MACKAY 2014

Alex Mackay, Alex Sumner, Zenobia Jacobs, Ben Marwick, Kyla Bluff & Matthew Shaw, *Putslaagte 1 (PL1), the Doring River, and the later Middle Stone Age in southern Africa's Winter Rainfall Zone*. [Quaternary International](#) **350** (2014), 43–58.

[QuatInt350-043-Supplement.pdf](#)

Existing data suggest weak human occupation of southern Africa's Winter Rainfall Zone (WRZ) during later Marine Isotope Stage (MIS) 3, the causes of which are unknown. Here we report briefly on the Results of recent surveys of alluvial terrace sites of the Doring River in the WRZ, which document occupation over a broad expanse of the later Middle Stone Age (MSA) and Pleistocene Later Stone Age. We then report on test excavations at one terrace site, denoted Putslaagte site 1 (PL1), describe in detail the assemblage of flaked stone artefacts produced from that excavation, and present two OSL ages obtained from 0.8 m to 1.5 m below surface. The results suggest that a) artefact accumulations at PL1 are dense, b) the technological systems documented are characteristically MSA but differ in form from the range of systems known from other excavated sites in the region, and c) that the assemblages accumulated in MIS 3. Taken together with the survey data the results introduce new variation into the later MSA in southern Africa, and imply reorganisation of land use in the WRZ in late MIS 3 rather than abandonment. We suggest that a research emphasis on rock shelter deposits may have produced misleading depictions of regional occupation.

**Keywords:** Middle Stone Age | Lithics | OSL | Southern Africa | MIS 3

## Aktuell

### GILANI 2019

Artaza Gilani, *The way I am*. [science 364 \(2019\), 202](#).

A year ago, I had one of the most significant interviews of my life. It was for a job I had worked toward for years, as a medical doctor doing research and teaching along with treating patients—a rare and highly competitive type of post in the United Kingdom. Toward the end of the interview, I was asked how I would balance the different parts of the role. I had expected this question and had thought about how I would answer. Still, I hesitated. I could say what I thought the members of the interview panel wanted to hear: I'm good at multitasking, prioritizing, and delegating, and I was confident that I would be able to juggle the various responsibilities. That would have been true—yet it didn't feel authentic. The more honest answer was that I knew it would be difficult, but I wanted to try anyway. I wasn't sure which answer to give.

### HIROSE 2019

Kentaro Hirose et al., *Evidence for hormonal control of heart regenerative capacity during endothermy acquisition*. [science 364 \(2019\), 184–188](#).

s364-0184-Supplement.pdf

Kentaro Hirose, Alexander Y. Payumo, Stephen Cutie, Alison Hoang, Hao Zhang, Romain Guyot, Dominic Lunn, Rachel B. Bigley, Hongyao Yu, Jiajia Wang, Megan Smith, Ellen Gillett, Sandra E. Muroy, Tobias Schmid, Emily Wilson, Kenneth A. Field, DeeAnn M. Reeder, Malcom Maden, Michael M. Yartsev, Michael J. Wolfgang, Frank Grützner, Thomas S. Scanlan, Luke I. Szweda, Rochelle Buffenstein, Guang Hu, Frederic Flamant, Jeffrey E. Olgin & Guo N. Huang

Tissue regenerative potential displays striking divergence across phylogeny and ontogeny, but the underlying mechanisms remain enigmatic. Loss of mammalian cardiac regenerative potential correlates with cardiomyocyte cell-cycle arrest and polyploidization as well as the development of postnatal endothermy. We reveal that diploid cardiomyocyte abundance across 41 species conforms to Kleiber's law—the  $\frac{3}{4}$ -power law scaling of metabolism with bodyweight—and inversely correlates with standard metabolic rate, body temperature, and serum thyroxine level. Inactivation of thyroid hormone signaling reduces mouse cardiomyocyte polyploidization, delays cell-cycle exit, and retains cardiac regenerative potential in adults. Conversely, exogenous thyroid hormones inhibit zebrafish heart regeneration. Thus, our findings suggest that loss of heart regenerative capacity in adult mammals is triggered by increasing thyroid hormones and may be a trade-off for the acquisition of endothermy.

### HITTINGER 2019

Eric Hittinger & Paulina Jaramillo, *Internet of Things, Energy boon or bane?* [science 364 \(2019\), 326–328](#).

Networked digital devices may cause rising energy use, although devices save energy locally.

### LIQUET Y GONZÁLEZ 2019

José E. Liquet y. González, *We regret to inform you*. [science 364 \(2019\), 302](#).

I woke up and groggily checked my phone—my morning routine. When I saw the email, I instantly became alert. It was from the National Science Foundation

Graduate Research Fellowship Program (NSF-GRFP), which offers a coveted award: 3 years of relatively generous funding and a healthy dose of prestige. My hopes were high. The previous year, when I applied as an undergraduate student with little mentoring, I had received an honorable mention. Now I was a first-year Ph.D. student, with a publication and a university fellowship to my name. The six people I had asked for input about my application—two of them actual reviewers for the fellowship—had given me positive feedback. I felt the key to career success was within my grasp.

LU 2019

Anhuai Lu et al., *Photoelectric conversion on Earth's surface via widespread Fe- and Mn-mineral coatings*. *PNAS* **116** (2019), 9741–9746.

[pnas116-09741-Supplement.pdf](#)

Anhuai Lu, Yan Li, Hongrui Ding, Xiaoming Xu, Yanzhang Li, Guiping Ren, Jing Liang, Yuwei Liu, Hao Hong, Ning Chen, Shengqi Chu, Feifei Liu, Yan Li, Haoran Wang, Cong Ding, Changqiu Wang, Yong Lai, Juan Liu, Jeffrey Dick, Kaihui Liu & Michael F. Hochella Jr.

Sunlight drives photosynthesis and associated biological processes, and also influences inorganic processes that shape Earth's climate and geochemistry. Bacterial solar-to-chemical energy conversion on this planet evolved to use an intricate intracellular process of phototrophy. However, a natural nonbiological counterpart to phototrophy has yet to be recognized. In this work, we reveal the inherent “phototrophic-like” behavior of vast expanses of natural rock/soil surfaces from deserts, red soils, and karst environments, all of which can drive photon-to-electron conversions. Using scanning electron microscopy, transmission electron microscopy, micro-Raman spectroscopy, and X-ray absorption spectroscopy, Fe and Mn (oxyhydr)oxide-rich coatings were found in rock varnishes, as were Fe (oxyhydr)oxides on red soil surfaces and minute amounts of Mn oxides on karst rock surfaces. By directly fabricating a photoelectric detection device on the thin section of a rock varnish sample, we have recorded an in situ photocurrent micromapping of the coatings, which behave as highly sensitive and stable photoelectric systems. Additional measurements of red soil and powder separated from the outermost surface of karst rocks yielded photocurrents that are also sensitive to irradiation. The prominent solar-responsive capability of the phototrophic-like rocks/soils is ascribed to the semiconducting Fe- and Mn (oxyhydr)oxide-mineral coatings. The native semiconducting Fe/Mn-rich coatings may play a role similar, in part, to photosynthetic systems and thus provide a distinctive driving force for redox (bio)geochemistry on Earth's surfaces.

**Keywords:** phototrophic | mineral coatings | birnessite | solar energy | redox (bio)geochemistry

**Significance:** In solar-terrestrial systems, solar energy input has long been recognized to have a profound impact on Earth. The wellknown photosynthetic systems enable sustainable solar-to-chemical energy conversion. However, no evidence has yet emerged for the existence of a widespread geological lightharvesting system. This study reveals such a “photoelectric device,” where semiconducting Fe- and Mn (oxyhydr)oxidemineral coatings are found to overlay vast expanses of natural rock/soil surfaces and exhibit highly responsive and stable photon-to-electron conversion. Our discovery may provide insight supporting vital photon-induced redox chemistry on Earth's surface via widespread Fe- and Mn-mineral coatings.

## MARCHIANÒ 2019

Silvia Marchianò & Charles E. Murry, *Lost in the fire*. [science](#) **364** (2019), 123–124.

Thyroid hormones tip the balance between regeneration and temperature regulation.

## PATSON 2019

Nikole D. Patson, *A cure for burnout*. [science](#) **364** (2019), 406.

“I am going to be on sabbatical at the same time!” I exclaimed to my former Ph.D. adviser. My certainty surprised me. I had recently earned tenure and become eligible for a sabbatical, but I had hesitated to take one. A break from teaching to focus on my research sounded nice in theory, but the truth was that I felt burned out on my science. I had no idea what I would do on a sabbatical, and the thought of losing the structure that teaching provides terrified me. Yet when I saw my former adviser at a conference and she mentioned that she would be spending the next year on sabbatical in a lab whose work I admired, something clicked. Maybe that was what I needed to get my spark back after the grueling, isolating process of getting tenure.

## SCHMUKLE 2019

Stefan C. Schmukle, Martin Korndörfer & Boris Egloff, *No evidence that economic inequality moderates the effect of income on generosity*. [PNAS](#) **116** (2019), 9790–9795.

[pnas116-09790-Supplement.pdf](#)

A landmark study published in PNAS [Côté S, House J, Willer R (2015) Proc Natl Acad Sci USA 112:15838–15843] showed that higher income individuals are less generous than poorer individuals only if they reside in a US state with comparatively large economic inequality. This finding might serve to reconcile inconsistent findings on the effect of social class on generosity by highlighting the moderating role of economic inequality. On the basis of the importance of replicating a major finding before readily accepting it as evidence, we analyzed the effect of the interaction between income and inequality on generosity in three large representative datasets. We analyzed the donating behavior of 27,714 US households (study 1), the generosity of 1,334 German individuals in an economic game (study 2), and volunteering to participate in charitable activities in 30,985 participants from 30 countries (study 3). We found no evidence for the postulated moderation effect in any study. This result is especially remarkable because (i) our samples were very large, leading to high power to detect effects that exist, and (ii) the cross-country analysis employed in study 3 led to much greater variability in economic inequality. These findings indicate that the moderation effect might be rather specific and cannot be easily generalized. Consequently, economic inequality might not be a plausible explanation for the heterogeneous results on the effect of social class on prosociality.

**Keywords:** social class | income | economic inequality | prosocial behavior | generosity

**Significance:** Are the rich less generous than the poor? Results of studies on this topic have been inconsistent. Recent research that has received widespread academic and media attention has provided evidence that higher income individuals are less generous than poorer individuals only if they reside in a US state with comparatively large economic inequality. However, in large representative datasets from the United States (study 1), Germany (study 2), and 30 countries (study 3), we did not find any evidence for such an effect. Instead, our results suggest that the rich are not less generous than the poor, even when economic inequality is

large. This result has implications for contemporary debates on what increasing inequality in resource distributions means for modern societies.

#### STROTHER 2019

Lars Strother, *A neural basis of the serial bottleneck in visual word recognition*. *PNAS* **116** (2019), 9699–9700.

The fact that you are unable to read the collection of words comprising this text all at once, as desirable as that may be, draws attention to a defining property of the human brain: its limited information processing capacity. The authors, in a previous behavioral study (2), used a similar task to show that even highly skilled readers are able to recognize only one word at a time. In the current study, participants performed the task during fMRI scanning, which measures blood oxygen level-dependent (BOLD) signals with millimeter-level spatial resolution. Their main goal was to identify the neural basis of a serial bottleneck revealed in the behavioral study mentioned previously (2), with a specific focus on retinotopic visual cortex and ventral occipitotemporal cortex (VOTC). To some degree, the ability of left VOTC to process visual inputs from both the RVF and the LVF is explained by its direct inheritance of contralateral (RVF) inputs via retinotopic cortex in the same hemisphere, and by the transfer of ipsilateral (LVF) inputs from homotopic regions the opposite hemisphere via the corpus callosum (12). Nevertheless, White et al.'s (1) finding that LVF and RVF channels originating in retinotopic cortex in each hemisphere converge in left VOTC is surprising because of the specific anatomical location of this convergence. The visual word form area (VWFA) of left VOTC was originally defined as having bilateral visual field (LVF and RVF) sensitivity to words (3). However, more recent fMRI findings suggest that bilateral word representation occurs in two distinct regions of left VOTC: the VWFA and a more posterior region of left VOTC (13).

#### WHITE 2019

Alex L. White, John Palmer, Geoffrey M. Boynton & Jason D. Yeatman, *Parallel spatial channels converge at a bottleneck in anterior word-selective cortex*. *PNAS* **116** (2019), 10087–10096.

[pnas116-10087-Supplement.pdf](#)

In most environments, the visual system is confronted with many relevant objects simultaneously. That is especially true during reading. However, behavioral data demonstrate that a serial bottleneck prevents recognition of more than one word at a time. We used fMRI to investigate how parallel spatial channels of visual processing converge into a serial bottleneck for word recognition. Participants viewed pairs of words presented simultaneously. We found that retinotopic cortex processed the two words in parallel spatial channels, one in each contralateral hemisphere. Responses were higher for attended than for ignored words but were not reduced when attention was divided. We then analyzed two word-selective regions along the occipitotemporal sulcus (OTS) of both hemispheres (subregions of the visual word form area, VWFA). Unlike retinotopic regions, each word-selective region responded to words on both sides of fixation. Nonetheless, a single region in the left hemisphere (posterior OTS) contained spatial channels for both hemifields that were independently modulated by selective attention. Thus, the left posterior VWFA supports parallel processing of multiple words. In contrast, activity in a more anterior word-selective region in the left hemisphere (mid OTS) was consistent with a single channel, showing (i) limited spatial selectivity, (ii) no effect of spatial attention on mean response amplitudes, and (iii) sensitivity to lexical properties of only one attended word. Therefore, the visual system can process two

words in parallel up to a late stage in the ventral stream. The transition to a single channel is consistent with the observed bottleneck in behavior.

**Keywords:** visual word recognition | visual word form area | spatial attention | divided attention | serial processing

**Significance:** Because your brain has limited processing capacity, you cannot comprehend the text on this page all at once. In fact, skilled readers cannot even recognize just two words at once. We measured how the visual areas of the brain respond to pairs of words while participants attended to one word or tried to divide attention between both. We discovered that a single word-selective region in left ventral occipitotemporal cortex processes both words in parallel. The parallel streams of information then converge at a bottleneck in an adjacent, more anterior word-selective region. This result reveals the functional significance of subdivisions within the brain's reading circuitry and offers a compelling explanation for a profound limit on human perception.

## Anthropologie

CHEN 2019

Fahu Chen et al., *A late Middle Pleistocene Denisovan mandible from the Tibetan Plateau*. [nature](#) **569** (2019), 409–412.

n569-0409-Supplement1.pdf, n569-0409-Supplement2.xlsx

Fahu Chen, Frido Welker, Chuan-Chou Shen, Shara E. Bailey, Inga Bergmann, Simon Davis, Huan Xia, Hui Wang, Roman Fischer, Sarah E. Freidline, Tsai-Luen Yu, Matthew M. Skinner, Stefanie Stelzer, Guangrong Dong, Qiaomei Fu, Guanghui Dong, Jian Wang, Dongju Zhang<sup>2</sup> & Jean-Jacques Hublin

Denisovans are members of a hominin group who are currently only known directly from fragmentary fossils, the genomes of which have been studied from a single site, Denisova Cave1–3 in Siberia. They are also known indirectly from their genetic legacy through gene flow into several low-altitude East Asian populations<sup>4,5</sup> and highaltitude modern Tibetans<sup>6</sup>. The lack of morphologically informative Denisovan fossils hinders our ability to connect geographically and temporally dispersed fossil hominins from Asia and to understand in a coherent manner their relation to recent Asian populations. This includes understanding the genetic adaptation of humans to the high-altitude Tibetan Plateau<sup>7,8</sup>, which was inherited from the Denisovans. Here we report a Denisovan mandible, identified by ancient protein analysis<sup>9,10</sup>, found on the Tibetan Plateau in Baishiya Karst Cave, Xiahe, Gansu, China. We determine the mandible to be at least 160 thousand years old through U-series dating of an adhering carbonate matrix. The Xiahe specimen provides direct evidence of the Denisovans outside the Altai Mountains and its analysis unique insights into Denisovan mandibular and dental morphology. Our results indicate that archaic hominins occupied the Tibetan Plateau in the Middle Pleistocene epoch and successfully adapted to high-altitude hypoxic environments long before the regional arrival of modern *Homo sapiens*.

WADE 2019

Lizzie Wade, *New species of ancient human unearthed*. [science](#) **364** (2019), 108.

*Homo luzonensis*, from the Philippines, may have been a small-bodied tree climber.

The teeth show a unique mosaic of traits found separately in other *Homo* species. The premolars are about the size of ours, but instead of a single root they have two or three—a primitive feature. The molars are much more modern, with



single roots, but “incredibly small” at only 10 millimeters across and 8 millimeters long. The long, curved fingers and toes resemble those of australopithecines like Lucy, an early human ancestor thought to have both walked upright and swung through the trees. “This is a very strong indication of climbing,” says paleoanthropologist Tracy Kivell, who studies hand bones at the University of Kent in Canterbury, U.K. Not everyone is ready to embrace these teeth and skeletal fragments as a separate species, rather than a locally adapted population of, say, *H. erectus*, an older hominin that lived in Asia for millennia.

WU 2019

Xiu-Jie Wu et al., *Archaic human remains from Hualongdong, China, and Middle Pleistocene human continuity and variation*. *PNAS* **116** (2019), 9820–9824.

[pnas116-09820-Supplement.pdf](#)

Xiu-Jie Wu, Shu-Wen Pei, Yan-Jun Cai, Hao-Wen Tong, Qiang Li, Zhe Dong, Jin-Chao Sheng, Ze-Tian Jin, Dong-Dong Ma, Song Xing, Xiao-Li Li, Xing Cheng, Hai Cheng, Ignacio de la Torre, R. Lawrence Edwards, Xi-Cheng Gong, Zhi-Sheng An, Erik Trinkaus & Wu Liu

Middle to Late Pleistocene human evolution in East Asia has remained controversial regarding the extent of morphological continuity through archaic humans and to modern humans. Newly found  $\approx 300,000$ -y-old human remains from Hualongdong (HLD), China, including a largely complete skull (HLD 6), share East Asian Middle Pleistocene (MPI) human traits of a low vault with a frontal keel (but no parietal sagittal keel or angular torus), a low and wide nasal aperture, a pronounced supraorbital torus (especially medially), a nonlevel nasal floor, and small or absent third molars. It lacks a malar incisure but has a large superior medial pterygoid tubercle. HLD 6 also exhibits a relatively flat superior face, a more vertical mandibular symphysis, a pronounced mental trigone, and simple occlusal morphology, foreshadowing modern human morphology. The HLD human fossils thus variably resemble other later MPI East Asian remains, but add to the overall variation in the sample. Their configurations, with those of other Middle and early Late Pleistocene East Asian remains, support archaic human regional continuity and provide a background to the subsequent archaic-to-modern human transition in the region.

**Keywords:** human paleontology | cranium | mandible | teeth | East Asia

**Significance:** Human evolution through the Middle to the Late Pleistocene in East Asia has been seen as reflecting diverse groups and discontinuities vs. a continuity of form reflecting an evolving population. New Middle Pleistocene ( $\approx 300,000$  y old) human remains from Hualongdong (HLD), China, provide further evidence for regional variation and the continuity of human biology through East Asian archaic humans. The HLD 6 skull is notable for its low and wide neurocranial vault and pronounced brow ridge, but less projecting face and modest chin. Along with the isolated teeth, the skull provides morphologically simple teeth with reduced or absent third molars. The remains foreshadow changes evident with modern human emergence, but primarily reinforce Old World continuity through Middle to Late Pleistocene humans.

## Archäologie

BRENTJES 1968

Burchard Brentjes, *Von Schanidar bis Akkad*. (Leipzig 1968).

KRUMM 2000

Alinde Krumm, *Ötzi's Braut, Nagita, das Mädchen aus dem Pfahlbau-dorf – eine Satire*. (Friedrichshafen 2000).

LICHTER 2008

Clemens Lichter & A. Wenzel, *Ur- und Frühgeschichte, Badisches Landesmuseum – Führer durch die archäologische Abteilung*. (Karlsruhe 2008).

MAASS 1995

Michael Maaß & Johanna Fabricius, *Antike Kulturen – Orient, Ägypten, Griechenland, Etrurien, Rom und Byzanz, Badisches Landesmuseum – Führer durch die Antikensammlungen*. (Karlsruhe 1995).

RÖLLIG 1961

Wolfgang Röllig, *Bildatlas der assyrisch-babylonischen Kultur*. (Gütersloh 1961). Original: M. A. Beek, *Atlas van het Tweestromen-land*.

## **Bibel**

RICHELLE 2012

Matthieu Richelle, *The Bible & Archaeology*. (Peabody 2018). Original: *La Bible et l'archéologie*.

SCHAUDIG 2019

Hanspeter Schaudig, *The Magnanimous Heart of Cyrus, The Cyrus Cylinder and its Literary Models*. In: M. RAHIM SHAYEGAN (Hrsg.), *Cyrus the Great, Life and Lore*. (Boston 2019), 67–91.

When Cyrus king of Ansan crossed the Tigris with the troops of the Gutians and the Umman-Manda, this meant absolute terror for the Babylonians. At the end of the third millennium, Ansan and Elam had wiped out the empire of the famous Third Dynasty of Ur. At the end of the second millennium, Sutruk-Nahhunte and his son Kutir-Nahhunte, “kings of Anan and Susa,” had eliminated the Kassite dynasty. Assisted by the Umman-Manda, they had devastated Babylonian cities and temples. With Cyrus, yet another king of Ansan had arisen who was marching with the barbarian hordes of the Gutians and the Umman-Manda towards Babylonia. This could only signify complete and utter destruction.

In order to appreciate fully the surprise of the Babylonians when the king of Ansan, the Gutians, and the Umman-Manda entered Babylon peacefully and paid his homage to Marduk and Esagil, we should translate these elements into a tale about the king of the Huns leading Gog and Magog against Rome, and turning all of a sudden into a woolly lamb at the gates of Saint Peter's Basilica.

The capture of Babylon by Cyrus was quite a remarkable event in its own right. But it turned into a miracle induced by Marduk himself when the Babylonians presented their reading of history on the basis of the Enuma elis and the Esagil Chronicle to account for the “righteous heart of Cyrus,” and the punishment of the wicked Nabonidus. Before the eyes of the Babylonians, their sacred scriptures had been fulfilled.



SHAYEGAN 2019

M. RAHIM SHAYEGAN (Hrsg.), *Cyrus the Great, Life and Lore*. (Boston 2019).

The edited volume *Cyrus the Great: Life and Lore* re-contextualizes Cyrus's foundational act and epoch in light of recent scholarship, while examining his later reception in antiquity and beyond. Among the many themes addressed in the volume are: the complex dossier of Elamo-Persian acculturation; the Mesopotamian antecedents of Cyrus's edict and religious policy; Cyrus's Baupolitik at Pasargadae, and the idiosyncratic genesis of Persian imperial art; the Babylonian exile, the Bible, and the First Return; Cyrus's exalted but conflicted image in the later Greco-Roman world; his reception and programmatic function in genealogical constructs of the Hellenistic and Arsacid periods; and finally Cyrus's conspicuous and enigmatic evanescence in the Sasanian and Muslim traditions.

The sum of these wide-ranging contributions assembled in one volume, as well as a new critical edition and English translation of the Cyrus Cylinder, allow for a more adequate evaluation of Cyrus's impact on his own age, as well as his imprint on posterity.

## Energie

HUAN 2019

Tran Ngoc Huan et al., *Low-cost high-efficiency system for solar-driven conversion of CO<sub>2</sub> to hydrocarbons*. *PNAS* **116** (2019), 9735–9740.

[pnas116-09735-Supplement.pdf](#)

Tran Ngoc Huan, Daniel Alves Dalla Corte, Sarah Lamaison, Dilan Karapinar, Lukas Lutz, Nicolas Menguy, Martin Foldyna, Silver-Hamill Turren-Cruz, Anders Hagfeldt, Federico Bella, Marc Fontecave & Victor Mougel

Conversion of carbon dioxide into hydrocarbons using solar energy is an attractive strategy for storing such a renewable source of energy into the form of chemical energy (a fuel). This can be achieved in a system coupling a photovoltaic (PV) cell to an electrochemical cell (EC) for CO<sub>2</sub> reduction. To be beneficial and applicable, such a system should use low-cost and easily processable photovoltaic cells and display minimal energy losses associated with the catalysts at the anode and cathode and with the electrolyzer device. In this work, we have considered all of these parameters altogether to set up a reference PV–EC system for CO<sub>2</sub> reduction to hydrocarbons. By using the same original and efficient Cu-based catalysts at both electrodes of the electrolyzer, and by minimizing all possible energy losses associated with the electrolyzer device, we have achieved CO<sub>2</sub> reduction to ethylene and ethane with a 21% energy efficiency. Coupled with a state-of-the-art, low-cost perovskite photovoltaic minimodule, this system reaches a 2.3% solar-to-hydrocarbon efficiency, setting a benchmark for an inexpensive all–earth-abundant PV–EC system.

**Keywords:** electrocatalysis | PV–EC | CO<sub>2</sub> reduction | electrolyzer | copper dendrites

**Significance:** Carbon dioxide electroreduction may constitute a key technology in coming years to valorize CO<sub>2</sub> as high value-added chemicals such as hydrocarbons and a way to store intermittent solar energy durably. Based on readily available technologies, systems combining a photovoltaic (PV) cell with an electrolyzer cell (EC) for CO<sub>2</sub> reduction to hydrocarbons are likely to constitute a key strategy for tackling this challenge. However, a low-cost, sustainable, and highly efficient PV–EC system has yet to be developed. In this article, we show that this goal can be reached using a low-cost and easily processable perovskite photovoltaic

minimodule combined to an electrolyzer device using the same Cu-based catalysts at both electrodes and in which all energy losses have been minimized.

## KUNENE 2019

Thabiso Kunene, Lu Xiong & Joel Rosenthal, *Solar-powered synthesis of hydrocarbons from carbon dioxide and water*. *PNAS* **116** (2019), 9693–9695.

CO<sub>2</sub> reduction product distributions under the solar-driven conditions leaned heavily toward hydrocarbon production, with ethylene (FY of 34%) and ethane (FY of 7%) predominating over C<sub>1</sub> products by nearly a 4:1 margin. When taken together, these Results correspond to a solar-to-hydrocarbon efficiency of 2.3%, which represents a new benchmark for the direct solar-driven synthesis of hydrocarbons using a PV-EC that does not rely on precious elements.

Although this PV-EC system sets a new standard for direct solar-to-hydrocarbon conversion efficiency, the DN-CuO catalyst directs more than 40% of the EC current to hydrogen evolution, as opposed to CO<sub>2</sub>RR. Since H<sub>2</sub> is of far lower commodity value than ethylene, propylene, and nonvolatile CO<sub>2</sub>RR products (HCO<sub>2</sub>H, CH<sub>3</sub>CO<sub>2</sub>H, CH<sub>3</sub>CH<sub>2</sub>OH), this side reaction represents a parasitic process that must be mitigated if CO<sub>2</sub>-to-hydrocarbon electrolysis is to become commercially viable.

## Klima

## CARRAPA 2019

Barbara Carrapa, Mark Clementz & Ran Feng, *Ecological and hydroclimate responses to strengthening of the Hadley circulation in South America during the Late Miocene cooling*. *PNAS* **116** (2019), 9747–9752.

pnas116-09747-Supplement1.pdf, pnas116-09747-Supplement2.xlsx

Near-modern ecosystems were established as a result of rapid ecological adaptation and climate change in the Late Miocene. On land, Late Miocene aridification spread in tandem with expansion of open habitats including C<sub>4</sub> grassland ecosystems. Proxy records for the central Andes spanning the Late Miocene cooling (LMC) show the reorganization of subtropical ecosystems and hydroclimate in South America between 15 and 35°S. Continental pedogenic carbonates preserved in Neogene basins record a general increase of δ<sup>18</sup>O and δ<sup>13</sup>C values from pre-LMC to post-LMC, most robustly occurring in the subtropics (25 to 30°S), suggesting aridification and a shift toward a more C<sub>4</sub>-plant-dominated ecosystem. These changes are closely tied to the enhancement of the Hadley circulation and moisture divergence away from the subtropics toward the Intertropical Convergence Zone as revealed by climate model simulations with prescribed sea-surface temperatures (SSTs) reflecting different magnitudes of LMC steepening of equator-to-pole temperature gradient and CO<sub>2</sub> decline.

**Keywords:** Late Miocene cooling | South America | Hadley circulation | stable isotopes | Andes

**Significance:** This paper analyzes the Late Miocene continental record of hydroclimate from the central Andes and subsequent ecological response to climatic change during this interval. The Late Miocene cooling (LMC) is characterized by a sharp decrease (up to 6 °C) of sea-surface temperatures and has been shown to have driven ecosystem reorganization, leading to conditions similar to Quaternary. We use the stable isotopic record preserved in pedogenic carbonate nodules as a

proxy for hydroclimate changes during the LMC. This, combined with general circulation simulations, shows that strengthening of the Hadley circulation in South America during the LMC enhanced subtropical aridification and in turn promoted expansion of C4 grasses and evolution of high-crowned teeth in mammals.

#### COMPTON 2011

John S. Compton, *Pleistocene sea-level fluctuations and human evolution on the southern coastal plain of South Africa*. [Quaternary Science Reviews](#) **30** (2011), 506–527.

Humans evolved in Africa, but where and how remain unclear. Here it is proposed that the southern coastal plain (SCP) of South Africa may have served as a geographical point of origin through periodic expansion and contraction (isolation) in response to glacial/interglacial changes in sea level and climate. During Pleistocene interglacial highstands when sea level was above .75 m human populations were isolated for periods of 360–3400 25-yr generations on the SCP by the rugged mountains of the Cape Fold Belt, climate and vegetation barriers. The SCP expands five-fold as sea level falls from .75 to .120 m during glacial maxima to form a continuous, unobstructed coastal plain accessible to the interior. An expanded and wet glacial SCP may have served as a refuge to humans and large migratory herds and resulted in the mixing of previously isolated groups. The expansive glacial SCP habitat abruptly contracts, by as much as one-third in 300 yr, during the rapid rise in sea level associated with glacial terminations. Rapid flooding may have increased population density and competition on the SCP to select for humans who expanded their diet to include marine resources or hunted large animals. Successful adaptations developed on an isolated SCP are predicted to widely disperse during glacial terminations when the SCP rapidly contracts or during the initial opening of the SCP in the transition to glacial maxima. The hypothesis that periodic expansion and contraction of the SCP, as well as the coastal plain of North Africa, contributed to the stepwise origin of our species over the last 800 thousand years (kyr) is evaluated by comparing the archeological, DNA and sea-level records. These records generally support the hypothesis, but more complete and well dated records are required to resolve the extent to which sea-level fluctuations influenced the complex history of human evolution.

**Keywords:** Human evolution | Allopatry | Sea level | Shelf | Pleistocene | South Africa | Maghreb

#### HARTMANN 2019

Jens Hartmann, *Plate tectonics, carbon, and climate*. [science](#) **364** (2019), 126–127.

Enhanced weathering of uplifted rocks in the tropics may have driven past glaciations.

#### LAVIOLETTE 2019

Paul A. LaViolette, *Evidence for a Global Warming at the Termination I Boundary and Its Possible Cosmic Dust Cause*. [unknown](#) (2019), preprint, 1–40. .

A comparison of northern and southern hemispheric paleotemperature profiles suggests that the Bölling-Alleröd Interstadial, Younger Dryas stadial, and subsequent Preboreal warming which occurred at the end of the last ice age were characterized by temperatures that changed synchronously in various parts of the world, implying that these climatic oscillations were produced by significant changes in the Earth's energy balance. These globally coordinated oscillations

are not easily explained by ocean current mechanisms such as bistable flipping of ocean deep-water production or regional temperature changes involving the NW/SE migration of the North Atlantic polar front. They also are not accounted for by Earth orbital changes in seasonality or by increases in atmospheric CO<sub>2</sub> or CH<sub>4</sub>. On the other hand, evidence of an elevated cosmic ray flux and of a major interstellar dust incursion around 15,800 years B.P. suggest that a cosmic ray wind driven incursion of interstellar dust and gas may have played a key role through its activation of the Sun and alteration of light transmission through the interplanetary medium.

#### MACDONALD 2019

Francis A. Macdonald, Nicholas L. Swanson-Hysell, Yuem Park, Lorraine Lisiecki & Oliver Jagoutz, *Arc-continent collisions in the tropics set Earth's climate state*. *science* **364** (2019), 181–184.

s364-0181-Supplement1.pdf, s364-0181-Supplement2.mp4

On multimillion-year time scales, Earth has experienced warm ice-free and cold glacial climates, but it is unknown whether transitions between these background climate states were the result of changes in carbon dioxide sources or sinks. Low-latitude arc-continent collisions are hypothesized to drive cooling by exhuming and eroding mafic and ultramafic rocks in the warm, wet tropics, thereby increasing Earth's potential to sequester carbon through chemical weathering. To better constrain global weatherability through time, the paleogeographic position of all major Phanerozoic arc-continent collisions was reconstructed and compared to the latitudinal distribution of ice sheets. This analysis reveals a strong correlation between the extent of glaciation and arc-continent collisions in the tropics. Earth's climate state is set primarily by global weatherability, which changes with the latitudinal distribution of arc-continent collisions.

## Metallzeiten

#### DELILE 2019

Hugo Delile et al., *Economic resilience of Carthage during the Punic Wars, Insights from sediments of the Medjerda delta around Utica (Tunisia)*. *PNAS* **116** (2019), 9764–9769.

pnas116-09764-Supplement1.pdf, pnas116-09764-Supplement2.xlsx, pnas116-09764-Supplement3.xlsx, pnas116-09764-Supplement4.xlsx

Hugo Delile, Elisa Pleuger, Janne Blichert-Toft, Jean-Philippe Goiran, Nathalie Fagel, Ahmed Gadhoun, Abdelhakim Abichou, Imed Ben Jerbania, Elizabeth Fentress & Andrew I. Wilson

While the Punic Wars (264–146 BC) have been the subject of numerous studies, generally focused on their most sensational aspects (major battles, techniques of warfare, geopolitical strategies, etc.), curiously, the exceptional economic resilience of the Carthaginians in the face of successive defeats, loss of mining territory, and the imposition of war reparations has attracted hardly any attention. Here, we address this issue using a newly developed powerful tracer in geoarchaeology, that of Pb isotopes applied to paleopollution. We measured the Pb isotopic compositions of a well-dated suite of eight deep cores taken in the Medjerda delta around the city of Utica. The data provide robust evidence of ancient lead–silver mining in Tunisia and lay out a chronology for its exploitation, which appears to follow the main periods of geopolitical instability at the time: the Greco-Punic Wars (480–307 BC) and the Punic Wars (264–146 BC). During the last conflict, the data further suggest that Carthage was still able to pay indemnities and fund

armies despite the loss of its traditional silver sources in the Mediterranean. This work shows that the mining of Tunisian metalliferous ores between the second half of the fourth and the beginning of the third century BC contributed to the emergence of Punic coinage and the development of the Carthaginian economy.

**Keywords:** paleopollution | mining resources | Medjerda river | Punic Wars | Utica

**Significance:** How do we explain the exceptional economic resilience for more than a century and a half of the Carthaginian civilization during the Punic Wars? Based on eight deep cores taken in the Medjerda delta around the city of Utica in Tunisia, we show that the sustainable retreat of Carthage into its hinterland during this period of warfare provided the metal resources whose exploitation by the Carthaginians was sufficient to resist the Romans for so long. The earliest phase of mining activity recorded in the Utica sediments occurred during the Greco-Punic Wars (480–307 BC) and is coeval with the first minting of Punic coins at Carthage, from which point on the Carthaginian economy became increasingly monetized.

## Neolithikum

FULLER 2011

Dorian Q. Fuller, George Willcox & Robin G. Allaby, *Cultivation and domestication had multiple origins, Arguments against the core area hypothesis for the origins of agriculture in the Near East*. [World Archaeology](#) **43** (2011), 628–652.

This paper debates claims that plant domestication occurred rapidly in a single restricted sub-section of the Near Eastern Fertile Crescent. Instead we argue for numerous parallel processes of domestication across the region in the Early Holocene. While a previous generation of genetic results seemed to support a single ‘core area’, the accumulation of genetic evidence and refinements in Methods undermine this, pointing increasingly towards multiple geographical origins. We stress that it is important to recognize that modern germplasm collections are an imperfect sample of the diversity of wild and cultivated populations of the past, which included some extinct lineages. We briefly synthesize the accumulated data from archaeobotany, defending the reliability of archaeological science to inform us about the past plant populations used by people. These data indicate an extended period of pre-domestication cultivation of at least a millennium and the slow evolution of morphological domestication adaptations in crop plants. The appearance of early cultivars and domesticates was spread piecemeal around the Near East, and a whole crop package is not evident. The ‘core area’ claimed by some authors has no better claim for primacy or completeness in comparison to other parts of the Near East. Evidence from zooarchaeology similarly points towards a diffuse appearance of various domesticated animals. The ‘non-centric’ appearance of domesticates from the Near East is therefore similar to the emerging evidence from many other regions of the world where plants were domesticated. We develop a hypothesis of why this should be expected given that anatomically modern human ancestors shared practices of vegetation management and planting, the necessary background knowledge for cultivation. Cultivation then was not a rare discovery but was a strategic and systematic shift in economies. The question then becomes why it was developed in the particular regions and periods where it appeared.

**Keywords:** Neolithic | agriculture | centres of origin | archaeobotany | palaeoethnobotany | wild progenitors.

MÜLLER 2019

Johannes Müller, *Boom and Bust, Hierarchy and Balance, From landscape to social meaning – Megaliths and societies in Northern Central Europe*. In: JOHANNES MÜLLER, MARTIN HINZ & MARIA WUNDERLICH (Hrsg.), *Megaliths – Societies – Landscapes: Early Monumentality and Social Differentiation in Neolithic Europe, Proceedings of the international conference (16th–20th June 2015) in Kiel*. (Bonn 2019), 31–76.

Who and what triggered Neolithic monumentality, and why? As paleo-environmental and archaeological archives of the northern central European and southern Scandinavian Funnel Beaker societies have proven excellent, the reconstruction of their social processes linked with the introduction of agriculture and the construction of first monuments displays a well-researched example for investigating the triggers and meanings of Neolithic structures and processes. Within this article, the methodological basic approach, the research goals and some results of analyses within the SPP 1400 (DFG-Priority Program 1400) are used to describe and explain the development of monumentality in Northern Central Europe and southern Scandinavia.

## Politik

WADE 2019

Lizzie Wade, *Beliefs in aliens, Atlantis are on the rise*. [science 364 \(2019\), 110–111](#).

Researchers take to Twitter, blogs to counter pseudoarchaeology’s outlandish ideas.

Yet archaeologists have historically been hesitant to tackle pseudoarchaeology. As the field matured in the 20th century, archaeologists moved into the academy and abdicated the public sphere, says Sara Head, an independent cultural resources archaeologist in Philadelphia, Pennsylvania, and the author of the Archaeological Fantasies blog, who is co-organizing the SAA session. “We’ve created a vacuum” that pseudoarchaeology has filled.

Today, “Most archaeological research is unavailable to the public,” she says, obscured by jargon and locked behind paywalls. “But you want something from pseudoarchaeology? I can find you 15 references,” all easily accessible online and on TV.

## Story or Book

FRAPPIER 2019

Mélanie Frappier, *Helping Einstein*. [science 364 \(2019\), 136](#).

Efforts to identify Mileva Maric’s contributions highlight the trouble with telling the tales of early women in science.

*Einstein’s Wife: The Real Story of Mileva Einstein-Marić*. Allen Esterson and David C. Cassidy. MIT Press, 2019. 336 pp.

Unfortunately, this otherwise excellent essay is much too short to fully balance the occasional failure of Esterson and Cassidy’s arguments to be sensitive to the realities women continue to face in academia. In their evaluation of Maric’s abilities, for example, they continuously rely on a comparison between Maric’s and Einstein’s grades. But given that even today, professors mark female students more



harshly than their male counterparts, it is unclear why the two authors would give so much place to such data in their account.

#### RADEMACHER 2019

Anne Rademacher, *Why cities?* [science](#) **364** (2019), 245.

An archaeologist identifies urban areas as key aggregators of human social experience.

*Cities: The First 6,000 Years*. Monica L. Smith. Viking, 2019. 301 pp.

We are further reminded that the earliest cities did not always rise in the most habitable locales; Mesopotamia, for example, was hot and dry, and farming failed on an unpredictable basis. Early cities, then, may have witnessed the rise of strong social connections across differences in part because of the challenging circumstances they presented; people had to be creative, entrepreneurial, and interdependent in order to flourish.