the precursors must infiltrate the pores of the mould uniformly, without accumulating on the external surface; and the precursors must convert completely into the desired product. The method does, however, work particularly well when high temperatures (of the order of 500 °C or more) are needed to synthesize a mesoporous material. This contrasts with the use of surfactant-based soft templates, which typically decompose at temperatures above 200 °C.

Nanocasting was first used to make ordered mesoporous carbon[8], but has since been developed as a general approach for synthesizing nanowires and nanoporous materials of various compositions, including metal oxides, organic polymers and metals[10]. Mesoporous carbons have garnered much interest because of their high electrical conductivity[11], and because they can accommodate a large volume of guest atoms, molecules or particles inside the mesopores. For this reason, mesoporous carbons are considered to be particularly attractive candidates for electrode materials in chemical sensors[12], supercapacitors[13] and high-performance batteries[14].

Mesoporous materials are also gaining attention for biomedical applications such as drug or gene delivery[15,16]. Mesoporous silicas, in particular, can be synthesized in various shapes and sizes, are often biocompatible and spontaneously degrade in human tissues – a property that could be used to release drugs trapped in the silica. Moreover, the ability to accurately control the diameters of mesopores in silica is expected to provide tremendous advantages in biomedical applications, because the pore sizes directly affect the loading and release kinetics of drugs in delivery systems.

The main uses envisaged for mesoporous materials include as adsorbents in industrial processes for separating chemicals, and as catalysts in petrochemical refinery processes. Indeed, the original motivation for Kresge and colleagues' MCM-41 research was to synthesize catalytic materials for petroleum refining[17]. But although MCM-41 had sufficiently large pores for this purpose, its glass-like amorphous framework showed poor catalytic activity.

Ever since, enormous efforts have been made to synthesize mesoporous materials that contain crystalline, microporous, zeolite-like frameworks, which exhibit high catalytic performance. A breakthrough was made ten years ago, with the report of a specially designed surfactant molecule that enables the synthesis of such materials[18,19]. The catalytic properties of the resulting mesoporous zeolites have not been fully explored for industrial processes, because the required surfactant is costly and not yet commercially available. However, I expect that mesoporous zeolites will trigger the next explosion of research in this field, by opening up many opportunities for catalytic applications.

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Palaeontology

Evolutionary insights from *Australopithecus*

Dean Falk

In 1925, a *Nature* paper reported an African fossil of a previously unknown genus called *Australopithecus*. This finding revolutionized ideas about early human evolution after human ancestors and apes split on the evolutionary tree.

Australian-born Raymond Dart had barely started his job as chair of the anatomy department of the University of the Witwatersrand in Johannesburg, South Africa, when he made a momentous discovery. Using his wife's knitting needles, he painstakingly extracted a fossil (Fig. 1) from a chunk of rock found in Taungs (now known as Taung), South Africa. As he recalled[1], "the rock parted ... What emerged was a baby's face, an infant with a full set of milk teeth ... I doubt if there was any parent prouder of his offspring than I was of my 'Taungs baby' on that Christmas of 1924." Better yet, the fossil fitted neatly with another type of fossil, called an endocast, formed from sediments accumulated inside the skull. The endocast reflects brain-surface details stamped on the braincase's inner walls. These fossils revealed a combination of ape-like and human-like features never previously reported together.

Convinced that the specimen, called the Taung Child, represented an extinct link between humans and our ape ancestors, Dart dispatched a report[2] to *Nature* by mail boat. He probably felt some trepidation because several fellows of the Royal Society in London, who had mentored and taught with him, considered the human forerunner to be the British specimen known as Piltdown Man (which was later exposed as a hoax). Piltdown Man's human-sized brain and ape-like jaw contrasted with the Taung Child's ape-sized brain and human-like jaw and teeth. In Dart's view, the Taung Child looked more primitive and older than the main existing candidates for the earliest ancestral human relative – Piltdown Man and Java Man (*Homo erectus*) from Indonesia. Dart therefore described the Taung Child as a 'man-ape' rather than an 'ape-man', like Java Man, and named the species *Australopithecus africanus*, which means southern ape from Africa.

Dart declared that humankind's cradle was not in Indonesia or Britain as his contemporaries thought, but was instead in Africa, as Charles Darwin had previously suggested[3]. The comfortable habitats favoured by African chimpanzees and gorillas in Dart's time were more than 3,200 kilometres north of where the Taung Child dwelled, and Dart suggested in his 1925 *Nature* paper that intense competition for limited resources in harsh southern African landscapes "furnished a laboratory such as was essential to this penultimate phase of human evolution". In the paper, he also reasoned that "enhanced cerebral powers possessed by this group ... made their existence possible in this untoward environment", attributing intelligence based on his interpretation of human-like brain convolutions at the back of the specimen's endocast.

When the paper appeared, the Taung Child and 32-year-old Dart became world famous overnight. Yet not everyone was receptive to new ideas about human evolution. Indeed,

Figure 1 | Raymond Dart in 1925 holding the *Australopithecus africanus* fossil called the Taung Child.

five months later, a court case known as the Scopes monkey trial began in the United States to settle whether evolution could be taught in Tennessee schools. The immediate reaction to Dart's paper was mainly enthusiastic, but he soon became a target of 'you'll-burn-in-hell' letters from religious fundamentalists, and his former London colleagues published harsh criticisms of his research. Dart's main champion, the physician Robert Broom, remarked[4]: "It makes one rub one's eyes. Here was a man who had made one of the greatest discoveries in the world's history — a discovery that may yet rank in importance with Darwin's *Origin of Species*; and English culture treats him as if he had been a naughty schoolboy."

To answer his critics, Dart spent four years preparing a book[5] about the Taung Child. It provided voluminous extra details about the endocast, bones and teeth, and bolstered the argument that humans originated in Africa[6]. He submitted the book to the Royal Society, which declined to publish it. The pro-Piltdown fellows were probably behind this rejection[7]. Sadly, the book remains unpublished.

The most controversial aspect of Dart's paper, then and now, is his view that the back of the Taung Child's endocast is human-like. Some have argued that Dart misidentified a skull imprint as a brain groove similar to a human one, a feature that is inconsistent with the Taung Child's otherwise ape-like brain[8]. Dart's 1925 *Nature* paper describes two endocast brain grooves, but his book identifies 14 further grooves, and describes 3 dispersed brain regions that look expanded in comparison with those of ape brains. If these findings had been published, they might have influenced the still-controversial debate about whether the human brain evolved in a piecemeal, mosaic fashion or in a more globally connected manner. Some mosaicists still cite Dart's 1925 *Nature* paper, but his unpublished book reveals his globalist viewpoint.

Dart's paper stated: "we may confidently anticipate many complementary discoveries concerning this period in our evolution." Indeed, thousands of specimens have been found that represent various *Australopithecus* species that lived in Africa during different time spans from more than 4 million to around 1 million years ago. The fossil Lucy is an example of one such species, called *Australopithecus afarensis*.

Subsequent work confirmed that Dart got most of the details right regarding his discovery. *Australopithecus* shared features of both living apes and humans, and they were bipedal as he surmised because the skull opening that accommodates the spinal cord is positioned centrally at the base of the specimen's cranium. Dart correctly inferred[9] that hominins originated in Africa, and that our genus *Homo* arose from *Australopithecus*. Happily, he lived long enough to see his initially iconoclastic ideas become widely accepted.

I cannot help but wonder what Dart would have thought about another notable discovery reported in *Nature*[10] — the 2004 identification of a species called *Homo floresiensis* (the most complete specimen is nicknamed the Hobbit) from remains in Indonesia dating to approximately 100,000–60,000 years ago. Like the Taung Child, the *H. floresiensis* specimens showed a combination of features never previously found in a fossil specimen. *Homo floresiensis* had ape-like, *Australopithecus*-like and human-like traits, as well as a tiny brain, leading some to suggest that this species might be a lineage descended from a previously unknown early hominin migration out of Africa[11].

The parallels with Dart's discovery are remarkable. *Homo floresiensis* drew worldwide attention, but was also met with scorn from some scientists (who argued that the Hobbit represents an abnormal human). *Homo floresiensis*-like fossils dating to 700,000 years ago have since been reported[12], and its legitimacy as a species is gaining traction. It might be equally crucial for unravelling the evolution of early members of the human family tree outside Africa in the way that the Taung Child was essential for understanding the evolution of human ancestors in Africa. Only time will tell. One thing is certain, however; the more palaeoanthropology changes, the more palaeopolitics stays the same.

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