illuminations. Therefore, measurements should be taken before aging (open circle in bottom right figure panel) and after aging, including a resting period in the dark (solid circles in the bottom right figure panel) to determine the “reversible loss.” Devices with different starting performances vary largely: A low-efficiency device may be considerably less stable than a high-efficiency counterpart (see red and black lines in the bottom right figure panel). Hence, PSC aging routines need to disclose all data with absolute rather than relative (or “normalized”) values and ideally provide repeated measurements to ensure the validity of the data. Bare perovskite layers are very sensitive to extrinsic degradation, e.g., ambient moisture or oxygen (9). These can be remedied with encapsulation or, alternatively, an inert nitrogen atmosphere resembling “perfect encapsulation” (10, 11), but these procedures and conditions must be stated as well. The outlined aging routine is only a starting point and may well change as the understanding of aging mechanisms in PSCs is improved. However, it is along these parameters that a calibration curve for accelerated aging can be developed to start the process of establishing a standard.

The power outputs from PSCs are sufficiently high to make them serious contenders for sustainable energy sources. In the coming years, PSCs will undergo relentless scrutiny for one of the most important topics in terms of market viability: long-term stability. Unfortunately, characterizing PSCs is challenging because of ion mobility. These issues already cast serious doubt on the reliability of efficiency measurements from the early period of perovskite research. A critical self-reflection on aging standards is needed to establish a basis for norms and common procedures with the chief aim of providing an aging standard for one of the most important top-priority for one of the most important top-priority for one of the most important top-priority for one of the most important top-priorities. Accelerated aging can be developed to ensure the longevity of devices with different starting performances. The outlined aging routine resembles an inert nitrogen atmosphere, which includes an inert nitrogen atmosphere, which includes an inert nitrogen atmosphere, which includes an inert nitrogen atmosphere, which includes an inert nitrogen atmosphere, which includes an inert nitrogen atmosphere.

ANTHROPOLOGY

When did modern humans leave Africa?

A ~180,000-year-old fossil from Israel provides evidence for early forays of Homo sapiens into western Asia

By Chris Stringer and Julia Galway-Within

The skeletal features of our species, Homo sapiens, include a globular braincase, brow ridges that are divided into central and side portions, a flat and retracted midface, a chin on the lower jaw, and a narrow pelvis. Fossils showing many of these characteristics have been excavated from the Ethiopian sites of Omo Kibish and Herto, dated at ~195,000 and ~160,000 years ago, respectively (1). Possible more primitive members of the species are known from Jebel Irhoud (Morocco) and Florschad (South Africa), dated at ~315,000 and ~259,000 years ago, respectively (1). Yet, the oldest known Homo sapiens fossils outside of Africa, from Skhul and Qafzeh in Israel, have been dated to just 90,000 to 120,000 years old. On page 456 of this issue, Hershkovitz et al. (2) provide fossil evidence from Misliya Cave, Israel, suggesting that our species had already left Africa by ~180,000 years ago (see the figure).

Misliya Cave lies on Mount Carmel, Israel, and has been excavated over the last century. It shows successive periods of hominin occupation with Lower and Middle Paleolithic tools, the use of fire, and the exploitation of a diverse fauna. Given Misliya’s position at a crucial crossroads between Africa and Eurasia, the latest discoveries have enormous potential for understanding early populations of H. sapiens in western Asia.

The newly excavated material is represented by a partial upper jaw (Misliya-1), which includes some of the bone surrounding the tooth sockets, part of the cheekbone, the roof of the mouth, the bottom of the nasal cavity, and the complete upper left dentition. The size and shape of the specimen fall within the known range of variation of later H. sapiens fossils. Furthermore, Misliya-1 lacks the unique diagnostic features of Neandertals and earlier hominin species.

Hershkovitz et al. note Misliya-1’s similarities to the later Skhul and Qafzeh fossils, although the size of one of the tooth cusps in Misliya-1 is reduced relative to the other fossils. Individual traits associated with the morphology exhibited in Misliya-1 are sometimes seen in other hominin taxa, but the combination of traits is characteristic that of H. sapiens.

Stone tools excavated from the same stratigraphic layer as that of Misliya-1 show the use of Levallois technology, a complex tool preparation method involving a prepared core. This technology has also been identified in ~190,000- to 260,000-year-old artifacts from nearby Tabun Cave (3), but the material at Misliya represents the earliest known association of this industry with modern human fossils in the region. Levallois tools associated with putative early H. sapiens fossils have also been found at Jebel Irhoud (Morocco) (1), suggesting that the emergence of this tool technology may be linked with the appearance and dispersal of our species in both Africa and western Asia.

Hershkovitz et al. dated the fossil and archaeological specimens from Misliya using multiple methods. They used uranium-thorium dating to determine the age of tooth dentine samples; combined uranium-series and electron spin resonance techniques to directly date enamel samples; uranium-thorium dating to determine the age of the sediment adhering to the upper jaw; and thermoluminescence to measure the age of the burned tools found close to the fossil. Collectively, the results of these dating methods provide an estimated age of ~177,000 to 194,000 years for Misliya-1 and its associated artifacts.

It remains unclear where and when humans lived in western Asia in the period prior to that of the Misliya specimen. Fragmentary
fossils are known from the Israeli caves of Qesem and Zuttiyeh, the former consisting of isolated teeth dated to ~400,000 years old, the latter represented by a partial skull, perhaps of similar antiquity. Both show primitive traits, and some that are found in Neandertals or *H. sapiens* (4, 5). Archaeological evidence for occupation of the region spans the time between these fossils and Misliya, but imprecise dating makes it impossible to tell whether human presence was continuous or episodic.

Paleoclimatic reconstructions using speleothems, deep sea cores, and paleoenvironmental data suggest that there were several humid phases between 244,000 and 190,000 years ago, one or more of which could have facilitated the spread of *H. sapiens* into the region (6). But there were severe periods of aridity before and after this time, meaning that the region was probably more often a “boulevard of broken dreams” than a stable haven for early humans (7). Direct local evolutionary continuity between the population represented by the Misliya fossil and later Skhul and Qafzeh peoples thus seems unlikely.

If the Misliya population extended further into Eurasia, encountering Neandertals, this may have led to gene flow between these two lineages of humans. The main phases of genetic introgression from Neandertals into *H. sapiens* are estimated to have occurred between ~50,000 and 60,000 years ago (8), but genetic analyses of Neandertal fossils from Denisova Cave (Siberia, Russia) and Hohlenstein-Stadel (Germany) indicate at least one earlier phase of introgression, from *H. sapiens* into Neandertals. This event has been estimated at ~219,000 to 460,000 years ago, suggesting that it predated the Misliya fossil (9). The *H. sapiens* fossils from Misliya, Skhul, and Qafzeh could therefore represent relatively late excursions of our species from Africa. During earlier humid phases, western Asia could have attracted more primitive members of the *H. sapiens* and *H. neanderthalensis* lineages, providing repeated opportunities for exchanges of genes and technologies.

Beyond western Asia, evidence for early dispersals of *H. sapiens* prior to ~120,000 years ago is weak. Age estimates for fragmentary Chinese fossils from Zhiren and Daoxian Caves only range between ~80,000 and 113,000 years ago (10). The Misliya find is important in establishing an earlier dispersal of *H. sapiens* from Africa into western Asia. It also highlights how little we know about the early occupants of the region, nearly a century after the first discoveries from the caves of Zuttiyeh, Skhul, Qafzeh, and Tabun.

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**Earliest modern human migrations from Africa**

Hershkovitz *et al.* report an age of ~180,000 years for a modern human fossil from Misliya in Israel, suggesting that modern humans left Africa much earlier than previously thought.