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PRELIMINARY EXAMINATION: PAPER 2

SOURCE BOOKLET

There are 16 pages in this Source Booklet.

QUESTION 1

SOURCE A

ScienceDaily

Science News
from research organizations

Biologists experimentally trigger adaptive radiation

Date: March 5, 2019

Source: University of Utah

When naturalist Charles Darwin stepped onto the Galapagos Islands in 1835, he encountered a bird that sparked a revolutionary theory on how new species originate, with the so-called Darwin's finches becoming an emblem of adaptive radiation.

Scientists think that adaptive radiation generates much of the biodiversity on Earth, yet most studies focus on the groups that have already diversified. A new study took the opposite approach. University of Utah biologists experimentally triggered adaptive radiation; they used host-specific parasites isolated on individual pigeon "islands."

The scientists showed that descendants of a single population of feather lice adapted rapidly in response to preening (grooming of feathers), the pigeons' main defense. They found that preening drove rapid and divergent camouflage in feather lice which were transferred to different coloured rock pigeons. Over four years and 60 generations, the lice evolved heritable colour differences that spanned the full color range of the lice genus found on 300 bird species worldwide.

"The changes in colour that we saw are as light as the lightest species and as dark as the darkest species in the entire genus -- and this genus has been evolving for millions of years," said Sarah Bush, associate professor in biology and lead author of the paper. "The changes and selection that happens day to day are the same patterns that we see over millions of years."

This is the first study to show that the evolutionary changes that occurred within a single species in a small space of time, echoed changes seen among different species which diverged millions of years ago. "People have been trying to bridge micro- and macro- evolution for a long time," said Dale Clayton, professor in biology and co-author of the paper. "This study actually does it. That's a big deal."

The study published online on March 5 in the journal *Evolution Letters*.

<https://www.sciencedaily.com/releases/2019/03/190305083630.htm>

HOMEBIOLOGY NEWS

The First Bees Evolved on an Ancient Supercontinent More Than 120 Million Years Ago

By WASHINGTON STATE UNIVERSITY JULY 31, 2023

The Origins of Bees

The first bees evolved on an ancient supercontinent more than 120 million years ago, diversifying faster and spreading wider than previously suspected, a new study shows.

Led by Washington State University researchers, the study provides a new best estimate for when and where bees first evolved.

The results indicate their point of origin was in western Gondwana, an ancient supercontinent that at that time included today's continents of Africa and South America.

Broad Genome-Scale Data Analysis

A global team of researchers sequenced and compared genes from more than 200 bee species. They compared them with traits from 185 different bee fossils, as well as extinct species, developing an evolutionary history and genealogical models for historical bee distribution.

In what may be the broadest genomic study of bees to date, they analyzed hundreds to thousands of genes at a time to make sure that the relationships they inferred were correct.

Bees' Evolution From Wasps

Previous research established that the first bees likely evolved from wasps, transitioning from predators to collectors of nectar and pollen. This study shows they arose in arid regions of western Gondwana during the early Cretaceous period.

For the first time, we have statistical evidence that bees originated on Gondwana, we now know that bees are originally southern hemisphere insects."

Geographic Expansion and Diversification of Bees

The researchers found evidence that as the new continents formed, bees moved north, diversifying and spreading in a parallel partnership with angiosperms, the flowering plants. Later, they colonized India and Australia. All major families of bees appeared to split off about 65 million years ago—the era when dinosaurs became extinct.

Future Research and Conservation Efforts

The team aims to expand their efforts, sequencing and studying the genetics and history of more species of bees. Their findings are a useful first step in revealing how bees and flowering plants evolved together. Understanding how bees spread and filled their modern ecological niches could also help keep pollinator populations healthy.

People are paying more attention to the conservation of bees and are trying to keep these species alive where they are. This work opens the way for more studies on the historical and ecological stage.



Rapid evolution of insecticide resistance and patterns of pesticides usage in agriculture in the city of Yaoundé, Cameroon

[Nadège Sonhafouo-Chiana](#), [Leslie Diane Nkahe](#), [Christophe Antonio-Nkondjio](#)
[Parasites & Vectors](#) volume 15, Article number: 186 (2022)

Despite progress in malaria control registered during the last decade, following the large-scale deployment of insecticide-based interventions such as long-lasting insecticidal nets (LLINs) and indoor residual spraying (IRS), malaria remains an important public health problem in Africa.

Prevention strategies rely mainly on the use of LLINs. It is estimated that over 70% of households own at least a net and that 58% of the population uses nets regularly. However, the sustainability of these insecticide-based control interventions is challenged by the spread of insecticide resistance in main malaria vectors. Studies conducted across the country reported increased expansion of insecticide resistance in the major malaria vectors.

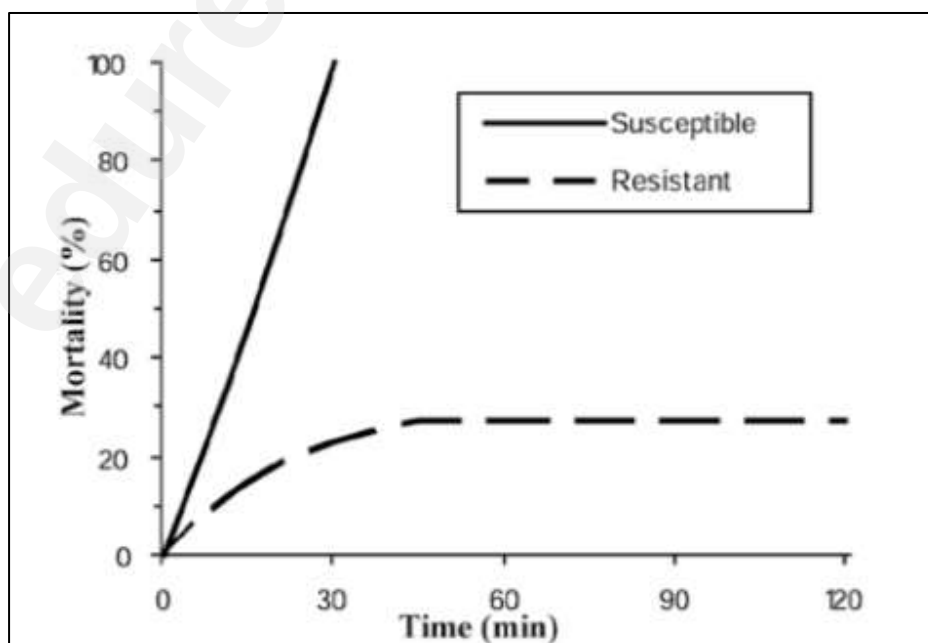
Pesticides used in agriculture are considered to largely contribute to the selection and spread of insecticide resistance with Mosquitoes becoming increasingly tolerant to several compounds.

The study sheds light on the evolution of insecticide resistance in malaria vectors and the factors which intensify the spread of insecticide resistance, highlighting the need for increased collaboration between the agricultural and public health sectors for better management of insecticide resistance.

<https://parasitesandvectors.biomedcentral.com/articles/10.1186/s13071-022-05321-8>

SOURCE E

Scientists investigated the rate at which mosquitoes were able to develop insecticide resistance against a specific compound. The graph below shows the mortality rate in a population of mosquitoes exposed to the pesticide over a 2 hour period.



[Source: Guideline for evaluating insecticide resistance in vectors using CDC Bioassay]

Horizon

The EU Research
& Innovation Magazine

HEALTH | FRONTIER RESEARCH

REPUBLIC 11

Wisdom teeth failing to appear as human jaw evolves

20 June 2016

By REX MERRIFIELD

Researchers are studying the evolutionary changes in human jaws to better understand the forces at play. Their work could help improve dental treatment and even regrow lost teeth.

The structure of our jaws has been millions of years in the making, from the earliest vertebrates to people settling down on farms, and it continues to evolve today.

In the past, anatomical changes, such as in the lower jaw, have gone hand-in-hand with changes in human diet. While it may be difficult to determine strict causality, researchers say there is clear evidence of adaptations in the jaw dating back to the transition to a more settled agricultural lifestyle, which took place in the Near East about 10 000 years ago.

As humans became more settled, the demands on their jaws changed,' said Dr Ekaterina Stansfield, principal investigator in the BioMan research project. The thinking is that hunter-gatherers would tend to have robust lower jaws, but following the transition to agriculture, cooking became widespread, resulting in considerably softer food and less chewing demand on the jaw.

'Jaw size and development may be driven more by usage, rather than predetermined by genetics,' Dr Stansfield said. 'We are looking at micro-evolution,' Dr Stansfield said. 'We hope to be able to show how the transition to agriculture has changed us and how this is continuing in the present.'

Professor Paul O'Higgins, BioMan research supervisor at the Hull-York Medical School, said such research also had long-term medical potential.

He pointed out that softer food in recent centuries has been accompanied by loss of the function of the third molar or 'wisdom teeth', with the actual loss of them over time in some cases, as many people no longer have them at all.

Hunter-gatherers and early farmers all have wisdom teeth. We have only lost them in the last few hundred years, as diets became extremely processed and extremely soft,' Prof. O'Higgins said.

In settling down to farm, humans also began to show geographical differences in their jaw structures, possibly because of diverging diets, said Professor Ron Pinhasi, who looked at the different rates of change in human tooth development and placement compared to the jaw.

He found that while dentition is more genetically determined, the size and shape of the jaw is not only controlled by genes, but also strongly affected by the environment. 'One of the surprising findings was the difference between the development of teeth and of the jaw,' he said. 'It is clear, there are very distinct differences between hunter-gatherers and the farmers.'

<https://ec.europa.eu/research-and-innovation/en/horizon-magazine/wisdom-teeth-failing-appear-human-jaw-evolves>

Before Agriculture, Human Jaws Were a Perfect Fit for Human Teeth

The emergence of agricultural practices initiated major changes to the jaw structure of ancient humans, leading to dental problems we still experience today.

Laura Clark

February 6, 2015

Our mouths often just don't have the space to accommodate all of our pearly whites—dental crowding is reportedly the most common reason for orthodontic referral and, along with malocclusion (a poor alignment of the teeth), affects one in five people.

Our ancient ancestors didn't have these same problems. Rather, as a new study has demonstrated, up until about 12,000 years ago, humans had what one of the study's lead authors called "an almost 'perfect harmony' between their lower jaws and teeth."

The big change, scientists say, came from civilization's transition from hunter-gatherers to farmers. The study, published this week in PLOS One, analysed "the lower jaws and teeth of 292 archaeological skeletons from Levant, Anatolia and Europe, from between 28,000-6,000 years ago

Scientists discovered a notable difference in jaw structure that coincided with the emergence of agriculture. As the head researcher says in a release:

"Our analysis shows that the lower jaws of the world's earliest farmers are not simply smaller versions of those of the predecessor hunter-gatherers, but that the lower jaw underwent a complex series of shape changes commensurate with the transition to agriculture."

Those changes likely came from diet, as previous studies have suggested. Hunter-gatherers needed big, strong jaws; however, early farmers didn't demand such a high level of strength. Over time, jaws became smaller in response to dietary changes; yet teeth didn't follow suit, remaining around the same size. This likely directly led to the problem of inadequate space in the mouth which is so common today. We've got modern jaws but a potentially outdated number of teeth.

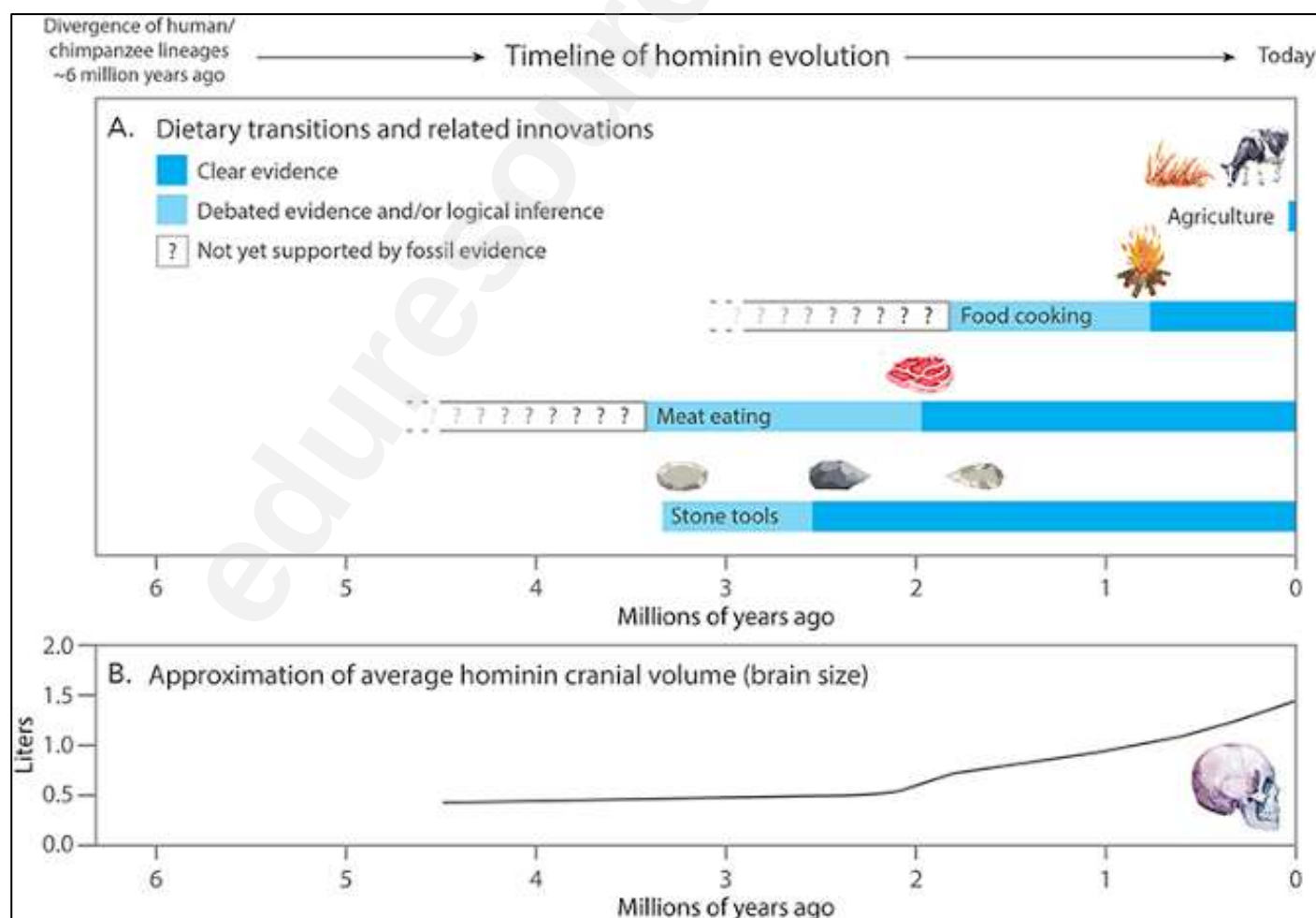
The switch to farming didn't only cause changes to our jawbones. Two studies published last year found that the emergence of agriculture likely resulted in other changes in humans, causing lighter, less-dense bones, particularly around joints. Such developments appear to be due to both diet and changes in physical activity, particularly the less active lifestyle allowed by farming and domesticating animals.

<https://www.smithsonianmag.com/smart-news/how-dawn-farming-changed-our-mouths-worst-180954167/>



<https://www.nature.com/scitable/knowledge/library/overview-of-hominin-evolution-89010983/>

SOURCE D



<https://evoanth.wordpress.com/2012/04/17/human-ancestors-used-tools-earlier-than-previously-thought/>

SCIENCE | FEBRUARY 2, 2021

An Evolutionary Timeline of Homo Sapiens

To understand how *Homo sapiens* evolved from older lineages of hominins, scientists look at different lines of evidence. This evidence increasingly indicates that *H. sapiens* originated in Africa, although not necessarily in a single time and place. Instead it seems diverse groups of human ancestors lived around Africa, evolving in isolation, until climate change caused them to mix and swap genes, eventually resulting in the unique genetic makeup of modern humans. The implication is that the human genome arose in Africa. Everyone is African, and yet not from any one part of Africa.

550,000 to 750,000 Years Ago: The Beginning of the Homo sapiens Lineage

Genes, rather than fossils, can help chart the migrations and evolution of our own species and those we interbred with over the ages. Genes clearly show that modern humans, Neanderthals and Denisovans share a common ancestor, however it is not clear who that ancestor is. *Homo heidelbergensis* is a popular candidate as it appears that this species leads to *H. Sapiens* in the African family tree while the European branch leads to *H. neanderthalensis* and Denisovans.

More 'ancient DNA;' would provide a clearer picture, but unfortunately, the cold, dry and stable conditions best for long-term preservation aren't common in Africa. Only a few ancient African human genomes older than 10 000 years have been sequenced, and there is currently no ancient DNA from Africa which is even close to the timeframe of our evolution between 800,000 and 300,000 years ago

Analysis of genetic information makes it clear that *Homo sapiens* originated on the African continent; however that we had a tendency to wander much earlier than scientists previously suspected.

A jawbone found inside a cave in Israel, reveals that modern humans dwelt there, alongside the Mediterranean, some 177,000 to 194,000 years ago. Not only are the jaw and teeth similar to those seen in modern humans, but they were also found with sophisticated handaxes and flint tools.

100,000 to 210,000 Years Ago: Fossils Show Homo sapiens Lived Outside of Africa

Homo sapiens groups were already living very far from Africa from 80,000 to 120,000 years ago, with even earlier migrations possible; some believe evidence exists of humans reaching Europe as long as 210,000 years ago.

While various groups of humans lived outside of Africa during this era, , they aren't part of our evolutionary story. Genetics can reveal which groups of people are our distant ancestors and whose had descendants eventually died out.

Few discoveries spark debate at the level of the Apidima skull fragment, from southern Greece, which could possibly represent the earliest modern human fossil discovered outside of Africa at more than 200,000 years old. However, the site is steeped in controversy, with many scholars believing that the badly preserved remains look more like Neanderthals, whose remains are found just a few feet away in the same cave. The accuracy of the dating analysis done at the site is also questioned due to the fossils being compromised a few years ago and falling by out of the geological layers in which they were deposited.

50,000 to 60,000 Years Ago: Genes and Climate Reconstruction Show Migration Out of Africa

Downloaded from eduresourceza.com

All living non-Africans, can trace most of their ancestry to humans who were part of a landmark migration out of Africa some 50,000 to 60,000 years ago, according to numerous genetic studies published in recent years. Reconstructions of climate suggest that lower sea levels created several advantageous periods for humans to leave Africa for the Arabian Peninsula and the Middle East, including one about 55,000 years ago.

“Just by looking at DNA from present day individuals we are able to infer a pretty good outline of human history,” Akey says. “A group dispersed out of Africa maybe 50 to 60 thousand years ago, that group then travelled around the world, eventually making it to all the habitable places on Earth”.

15,000 to 40,000 Years Ago: Homo sapiens Became the Only Surviving Human Species

Homo sapiens coexisted with other human species for most of our existence on, even interbreeding frequently with various hominin species, including some we haven't yet identified.

Our more mysterious cousins, the Denisovans, left behind so few identifiable fossils that scientists aren't sure what they looked like, or if they include more than one species. Many Asian people inherited 3-5% of their DNA from the Denisovans. All our close relatives eventually died out, leaving Homo sapiens as the only human species alive today.

Smithsonian Magazine. February 2021.

<https://www.smithsonianmag.com/science-nature/essential-timeline--evolution-homo-sapiens-1809768/>

SOURCE B

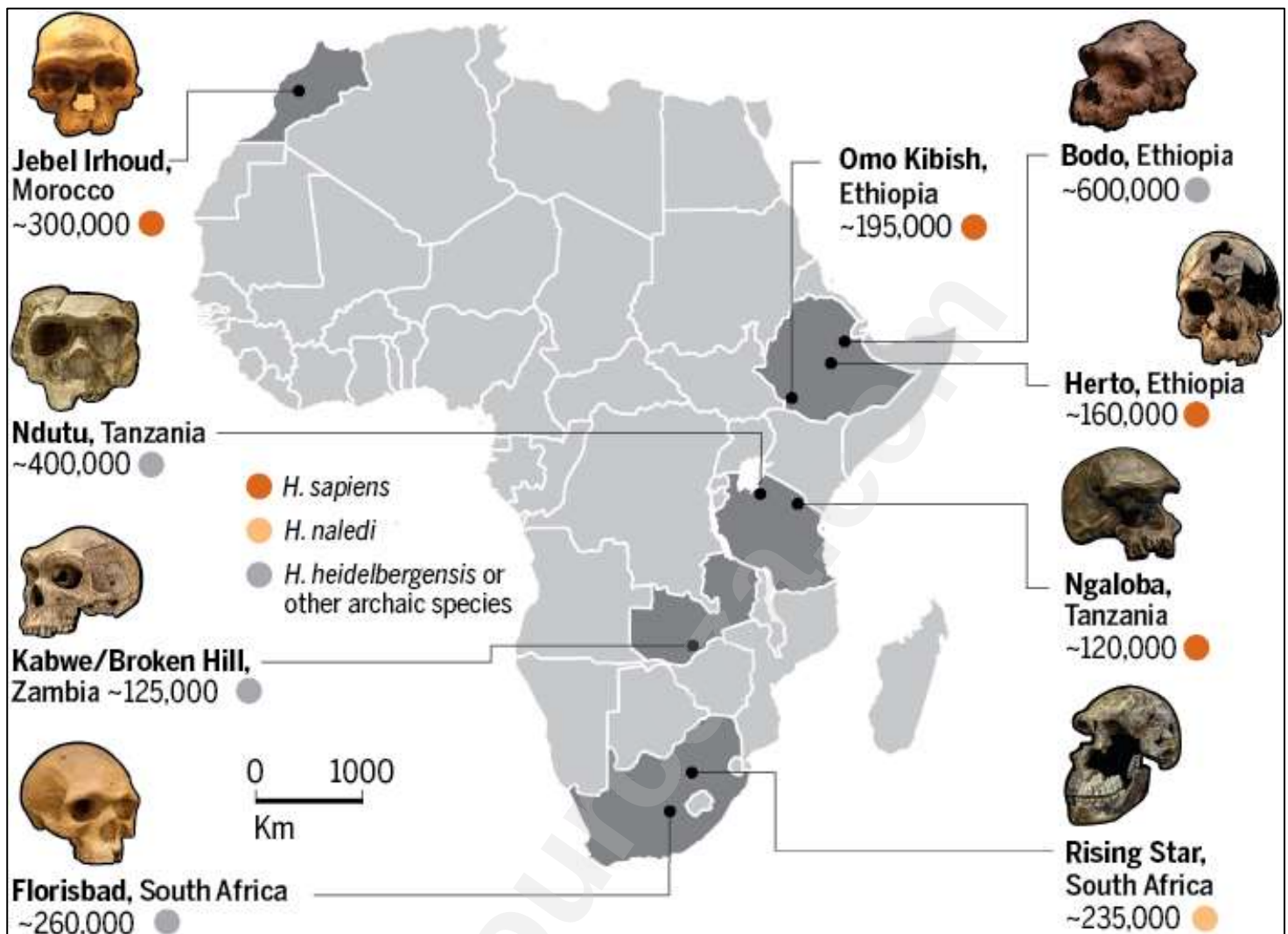


Researchers have uncovered the oldest known fossils of Homo sapiens along with stone tools and animal bones in Morocco. The fossils dating back about three lakh years push back the earliest evidence of human existence by one lakh years, confirming African origins of the species. The findings comprise skulls, teeth and long bones of at least five individuals.

Young Minds Newspaper. 2017

<https://youngmindsnewspaper.com/2017/06/08/oldest-known-human-fossils-found/>

Downloaded from eduresourceza.com



Science.com News- Archaeology. 2017

<https://www.science.org/content/article/world-s-oldest-homo-sapiens-fossils-found-morocco>
SOURCE D**DID MAN ORIGINATE IN MOROCCO?**

The earliest Homo sapiens fossils are found across the entire African continent: Jebel Irhoud, Morocco (300,000 years), Florisbad, South Africa (260,000 years), and Omo Kibish, Ethiopia (195,000 years).

This indicates a complex evolutionary history of our species, possibly involving the whole of Africa.

It's possible there's a centre of origin of our species somewhere on the continent, but to date, experts don't have a way to find where this is. It is unlikely Homo sapiens arose in one place in Africa and instead appeared in several locations across the continent.

BBC News 2017

<https://www.bbc.com/news/science-environment-40194150>

Ancient DNA Sheds New Light on Human Evolution during Out-of-Africa Migration

May 24, 2023 by [News Staff](#)

In new research, scientists identified a previously unsuspected extended period of genetic adaptation lasting around 30,000 years, potentially in the Arabian Peninsula area, prior to their subsequent rapid dispersal across Eurasia as far as Australia.

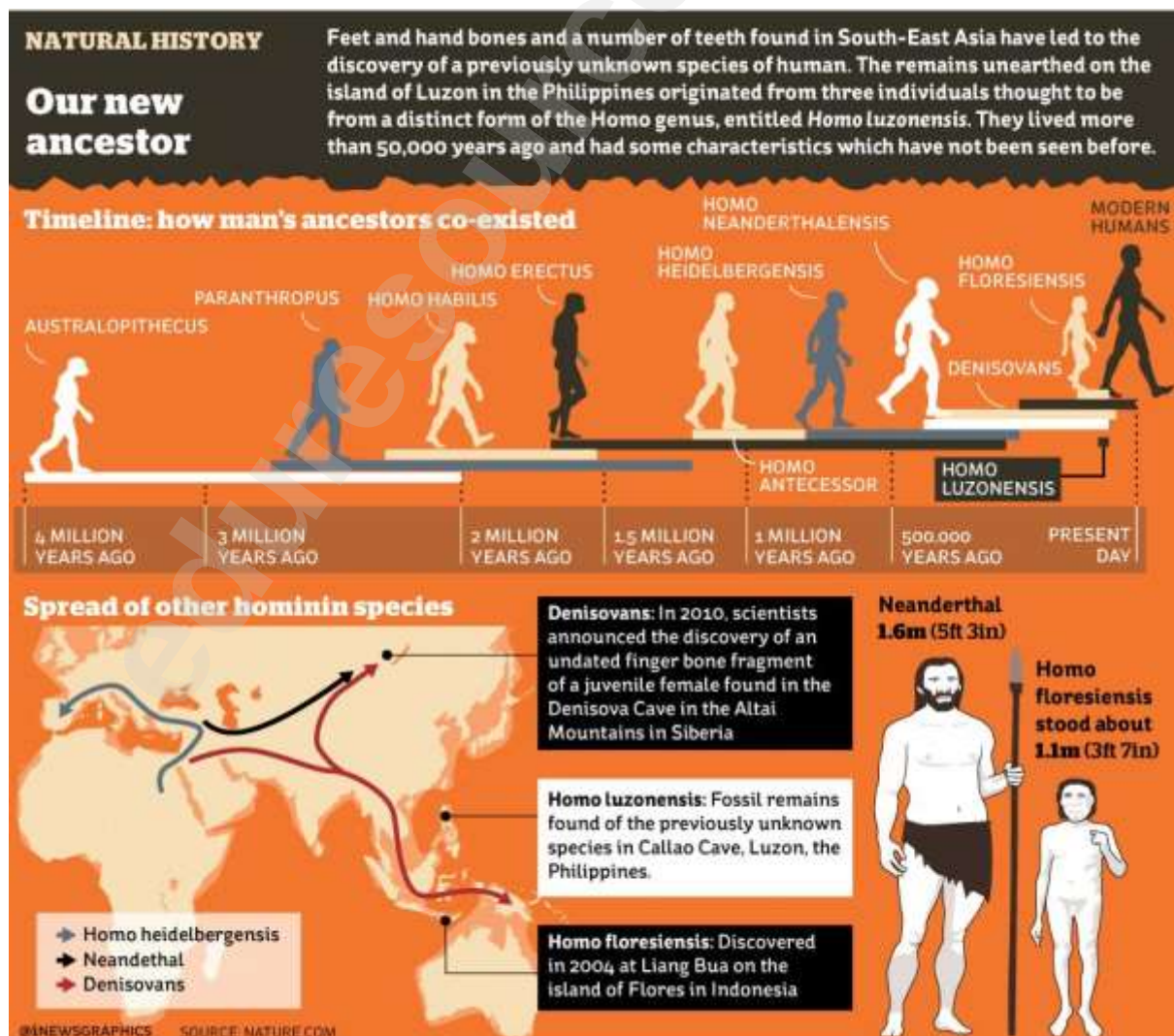
“We suspect the ‘Arabian Standstill’ period was a pivotal point in our evolutionary history, during which the ancestors of all non-African humans underwent extensive genetic adaptation to colder environments, effectively preparing them for the cool Eurasian environments they would eventually encounter.”

Ancient human genomes were used to reconstruct the poorly understood out-of-Africa diaspora. They found specific genetic patterns from a series of natural selection events dating back 80,000 years which suggest the ancestors of modern humans living outside of Africa experienced an extended period of genetic isolation and adaptation, prior to their worldwide dispersal 50,000 years ago.

Sci-News Website. May 2023

<https://www.sci.news/genetics/out-of-africa-human-evolution-11944.html>

SOURCE F



- 13 June 2023
- [Elsabé Brits](#)

A new model of human origins in Africa

Genetically differentiated Homo populations have been mixing for hundreds of thousands of years.

A new evolutionary model, [published](#) in *Nature*, examines questions around human origins in Africa. It finds that at least two evolutionary branches of Homo sapiens split, but continued to mix, over hundreds of thousands of years.

The model suggests the earliest detectable population split among early humans occurred 120,000 to 135,000 years ago, following prolonged mixing between two or more weakly genetically differentiated Homo populations.

This weakly structured stem contributed to the formation of an ancestral African human group, which then branched into contemporary African populations, as well as populations outside Africa.

“This model offers a better explanation of genetic variation among individual humans and human groups than previous models,” says Möller.

John Hawks, from the Department of Anthropology at the University of Wisconsin–Madison, says the new research does not totally rule out that such groups were among the ancestors of today’s people, but it says that most of our ancestors probably belonged to a few groups that interacted repeatedly for a very long time, maybe a million years.

Nature Africa – Online Review Journal. June 2023
<https://www.nature.com/articles/d44148-023-00145-9>

SOURCE H

WAS THE ORIGIN OF MAN MULTI-REGIONAL?

One theory on the origin of man suggests that modern humans developed in multiple regions around the world. The theory claims that groups of a pre-human ancestors made their way out of Africa and spread across parts of Europe and the Middle East. From here the species developed into modern humans in several places at once.

According to the multi-regional theory, different races arose in different regions as a result of natural selection as these populations evolved into modern humans.

The argument is supported by fossil evidence of early and pre-human ancestors found across Europe and the Middle East over the past 100 years.

It is also supported by a new analysis of a 260,000-year-old skull found in Dali County in China's Shaanxi Province. The skull suggests that early humans migrated to Asia, where they evolved modern human traits and then moved back to Africa.

Study Offers New Twist in How the First Humans Evolved

A new genetic analysis of 290 people suggests that humans emerged at various times and places in Africa. Scientists have revealed a surprisingly complex origin of our species, rejecting the long-held argument that modern humans arose from one place in Africa during one period in time.

By analyzing the genomes of 290 living people, researchers concluded that modern humans descended from at least two populations that coexisted in Africa for a million years before merging in several independent events across the continent. The findings were published on Wednesday in [Nature](#).

“There is no single birthplace,” said Eleanor Scerri, an evolutionary archaeologist. “It really puts a nail in the coffin of that idea.”

Paleoanthropologists and geneticists have found evidence pointing to Africa as the origin of our species.

- The oldest fossils that may belong to modern humans, dating back as far as 300,000 years, have been unearthed there. So were the oldest stone tools used by our ancestors.
- Human DNA also points to Africa. Living Africans have a vast amount of genetic diversity compared with other people. That’s because humans lived and evolved in Africa for thousands of generations before small groups — with comparatively small gene pools — began expanding to other continents.

Within the vast expanse of Africa, researchers have proposed various places as the birthplace of our species. Early humanlike fossils in Ethiopia led some researchers to look to East Africa. But some living groups of people in South Africa appeared to be very distantly related to other Africans, suggesting that humans might have a deep history there instead.

It’s possible they will discover other populations that endured in Africa for hundreds of thousands of years, ultimately helping produce our species as we know it today.

<https://www.nytimes.com/2023/05/17/science/human-origins-africa.html>

SOURCE J

The fossil that rewrites human history: 260,000-year-old Chinese skull suggests we descend from ASIAN as well as African ancestors

- 'Dali skull' is similar to the earliest known fossil of our species, found in Morocco
- This suggests modern humans aren't descended solely from African ancestors
- Instead, some early humans migrated to Eurasia before Homo sapiens existed
- Here they evolved some modern human traits, and then moved back to Africa
- In Africa the Asian early humans interbred with native populations
- The intermixing eventually led to Homo sapiens, which spread around the world
- Modern human DNA therefore came from both African and Eurasian ancestors

By [HARRY PETTIT FOR MAILONLINE](#)
UPDATED: 12:00 BST, 16 November 2017

The 10 Oldest Human Fossils Ever Found

Written by **Kaleigh Moore**

Updated: June 29, 2023

Technically speaking, the 10 oldest fossils ever were all from the time when humans were just beginning to differentiate from apes, about 4 to 7 million years ago.

There are several fossil discoveries from this epoch found mostly in Africa.

10 OLDEST HUMAN FOSSILS EVER FOUND



Graecopithecus, Greece, Bulgaria ~7 Million Years Ago

These remains have been the cause of much controversy

In 1944, a lower jawbone was discovered in Athens, Greece. Modern dating technology estimates that it's as old as 7.24 million years and very similar to a single upper premolar tooth found in Bulgaria.

These remains are attributed to Graecopithecus, an early ancestor of humans. Scientists determined that the jaw and tooth belonged to a human because the roots of the molar are partially fused, a distinctive feature of human teeth. The fused roots and other features are strong proof that the jaw belonged to a hominid. However, there's still a lot of controversy surrounding this extremely old find. For one, it suggests that humans first diverged from our ape-like ancestors in Europe, and not in Africa as commonly accepted.

Even worse, some paleontologists dispute that Graecopithecus was an early human ancestor. They say that it's more likely the fossils belong to an ancient ape species called Ouranopithecus, saying that a single tooth and jawbone are insufficient evidence of human origins.

Why we are not all multiregionalists now

Chris Stringer

DNA data show that archaic introgression into modern human genomes occurred. Such introgression is claimed to support the multiregional model for modern human origins.

This introgression is also claimed to support lumping of distinct human species into *Homo sapiens*

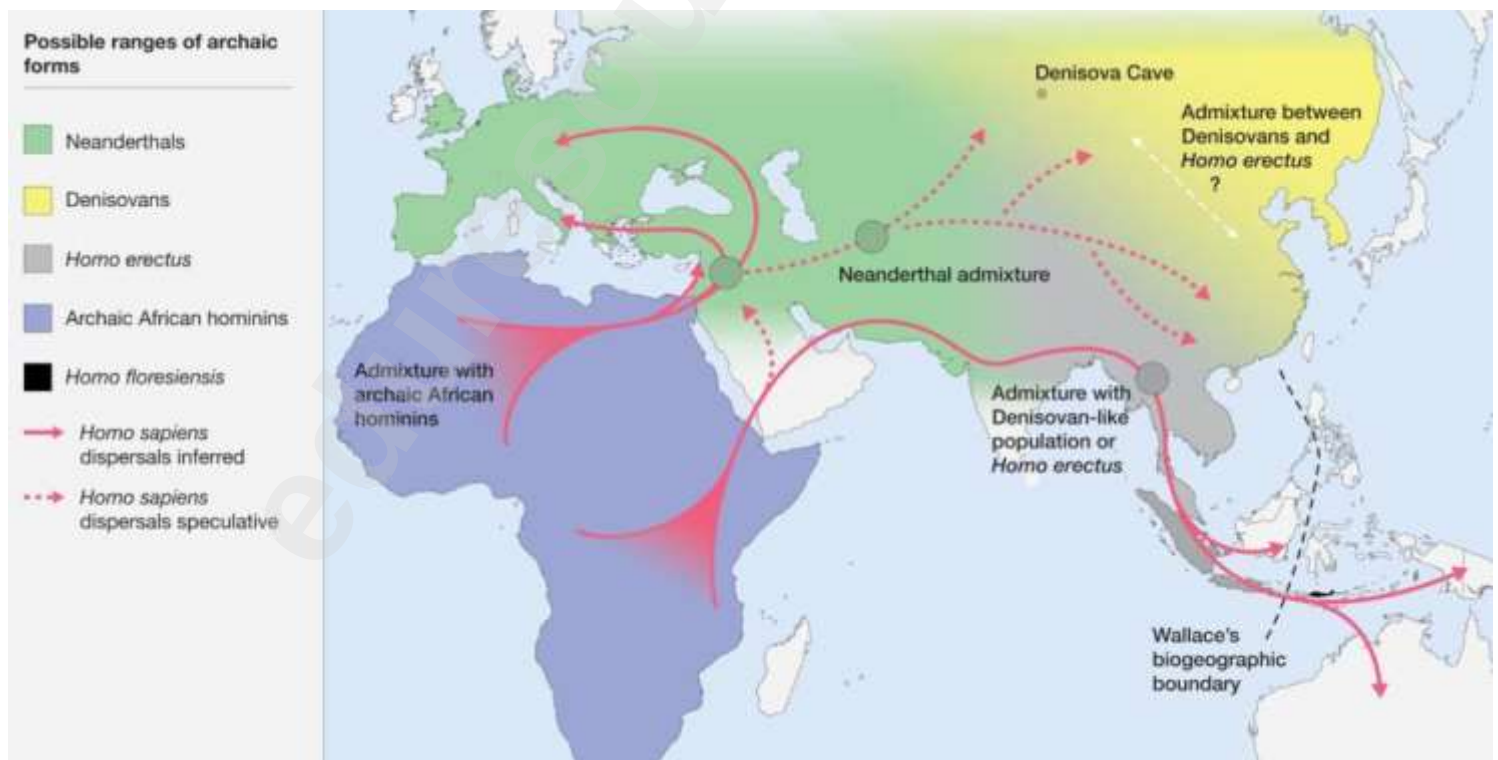
Comparing models and data still validates a recent African origin model for modern humans and the use of a restricted diagnosis for *H. sapiens*.

Recent revelations that human genomes contain DNA from interbreeding with archaic populations outside of Africa have led to reassessments of models for the origins of our species. The fact that small portions of the DNA of recent *Homo sapiens* derive from ancient populations in more than one region of the world makes our origins 'multiregional', but does that mean that the multiregional model of modern human origins has been proved correct?

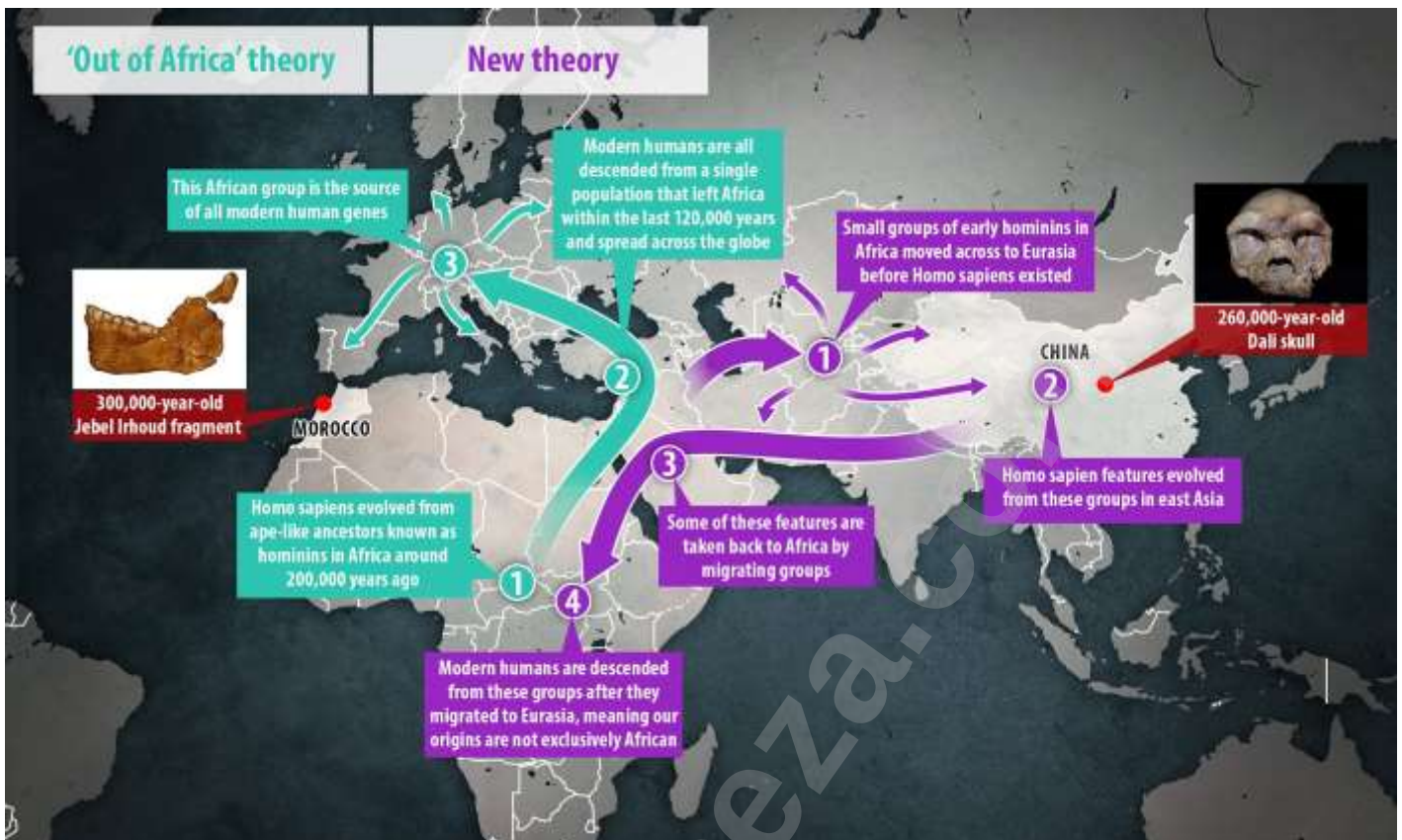
The extent of archaic assimilation in living humans remains modest, and fossil evidence outside of Africa shows little sign of the long-term morphological continuity through to recent humans expected from the multiregional model. Thus, rather than multiregionalism, a recent African origin (RAO) model for modern humans is still supported by the data.

Opinion piece by Chris Stringer. Academia Journal Website.
https://www.academia.edu/9578237/Why_we_are_not_all_multiregionalists_now

SOURCE M



Apsontheweb.zoom-maps.com/post/701551107787423744/the-expansion-of-humans-and-possible-ranges-of



- **Url** <https://www.britannica.com/animal/Bellerophon-fossil-gastropod#/media/1/270386/7612>
- **Access** 23 August 2023

SOURCE O

Chinese fossils analysed over the past four decades, cast doubt over the linear progression from African *H. erectus* to modern humans. They show that, between roughly 900,000 and 125,000 years ago, east Asia was teeming with hominins endowed with features that would place them somewhere between *H. erectus* and *H. sapiens*. Those fossils are a big mystery,” says Ciochon. “They clearly represent more advanced species than *H. erectus*, but nobody knows what they are because they don't seem to fit into any categories we know.”

The fossils' transitional characteristics have prompted researchers to lump them with *H. heidelbergensis*; however, many researchers, including most Chinese palaeontologists, contend that the materials from China are different from European and African *H. heidelbergensis* fossils.

Most Chinese palaeontologists think that the transitional fossils are evidence that hominins descended from *H. erectus* in Asia interbred with incoming groups from Africa and other parts of Eurasia. This model is known as multiregionalism.

Another possibility is that some of the Chinese fossils, including the Dali skull, represent the mysterious Denisovans, a species identified from Siberian fossils that are more than 40,000 years old. Palaeontologists don't know what the Denisovans looked like, but studies of DNA recovered from their teeth and bones indicate that this ancient population contributed to the genomes of modern humans, especially Australian Aborigines,

Wikipedia August 2023

<https://handwiki.org/wiki/index.php?curid=1263799>