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H. SAPIENS: A NEW DEPARTURE

A 52 MINUTES DOCUMENTARY BY OLIVIER JULIEN

SYNOPSIS

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BELLOTA FILMS Hind Saih, Producer +33 (0)6 15 91 33 59 hind-saih@bellotafilms.fr

ARTE FRANCE Céline Payot-Lehmann, Head of International Distribution +33 (0)6 62 54 02 05 c-payot-lehmann@artefrance.fr

DETAILED SYNOPSIS

INTRODUCTION

In June 2017, in the scientific journal *Nature*, an international team led by professors Jean-Jacques Hublin and Abdelouahed Ben Ncer published an article about their archeological finds at Jebel Irhoud, Morocco. The news went around the world: the team announced the discovery of *Homo sapiens* fossils that were 300,000 years old, according to thermoluminescence dating.

Their results contradicted the generally accepted theory placing the appearance of our species in East Africa 200,000 years ago. These remains are 100,000 older, and they were found over 6,000 kilometres from the region considered to be “the cradle of humanity.”

And this discovery did not come out of the blue. The first hominin skull was found there over 50 years ago. But its dating and interpretation have varied significantly ever since, influenced by historical vicissitudes, dating techniques, and the growth of our understanding of human evolution. Hublin and Ben Ncer were fascinated by Jebel Irhoud, and for 30 years, they had been dreaming of excavating it again.

Convinced of Jebel Irhoud’s extraordinary potential, they persuaded two institutions, the Moroccan National Institute of Archeology and Heritage (known as the INSAP, Institut National des Sciences de l’Archéologie et du Patrimoine) in Rabat and the Max Planck Institute in Leipzig, to provide them with all of the technological resources of modern archeology. There is absolutely no doubt that the finds at Jebel Irhoud are a turning point in the way we understand our ancestry. The site is now the richest and most accurately dated one in Africa for this period of time, and the only dig to have yielded *Homo sapiens* fossils alongside a collection of stone tools.

The team has correlated this information with other research carried out in the past few decades. They suggest a new vision of the setting and processes leading up to the emergence of modern man. North Africa, a gigantic territory that has hitherto been sidelined in the study of the origins of our species, must now be taken into account as one of the keys.

JJ Hublin: Today, *Homo sapiens* is the only human species inhabiting the world. But we were preceded by a whole family of other hominins which contained at least fifteen different species.

Research on the origin of our species focuses on determining how and when the *H. sapiens* line branched off and separated from that of other hominins, giving rise to modern man.

Irhoud shows us that the event occurred over a much longer period, and in a much more complex way, than the general consensus that held sway. Scientists had theorized a sub-Saharan Garden of Eden.

The discovery at Irhoud forces us to rewrite the history books. It gives us a radically new viewpoint from which to consider the background of modern humans, the evolution of the human mind, and the conditions surrounding migration out of Africa.

ACT 1: THE OLDEST *HOMO SAPIENS* IN THE WORLD

A) A find that was nearly forgotten

The site was discovered in 1961 by miners. Their digging uncovered an intriguing and nearly complete hominin skull. An excavation was undertaken. The bones and tools it yielded were interpreted as being those of African Neanderthals. According to Carbon 14 dating, they were estimated to be 40,000 years old.

For decades, the classification of these remains was questioned. The first paper Jean-Jacques Hublin ever published dealt with the subject. Gradually, further analysis convinced paleontologists that these human fossils were in fact those of an archaic form of the species *Homo sapiens*.

In the 1990s, one of the fossils was studied using a more recently developed dating technique, ESR (electronic spin resonance). According to this method, the site was older: it had been inhabited 160,000 years in the past.

Yet both Dr. Hublin and Dr. Ben Ncer still doubted these findings. ESR measurement calibrations were uncertain, and the Irhoud skulls seemed much older and more primitive than those that had been discovered in Ethiopia, and dated to nearly 200,000 years ago. At the time, they were considered to be the oldest traces of *Homo sapiens* ever found.

In 2005, a partnership was set up between the Max Planck Institute in Leipzig and the INSAP in Rabat. Hublin and Ben Ncer received funding to head up an international group of researchers. The goal was to resume excavation of the site to find evidence on the ground that would allow more accurate and reliable dating.

B) A milestone in human history

The dig that resumed in 2005 yielded a trove of new finds *in situ*. It made Irhoud one of the richest and best documented sites on the whole African continent.

The team recovered the remains of at least 5 different individuals: three adults, an adolescent, and a child (of about 7). They all possessed similar anatomical characteristics: a strange mixture of features typical of modern man, and other traits that are archaic.

The stone tools found alongside them were flints that had been chipped off from a prepared core, a relatively advanced Stone Age technology. According to **Shannon McPherron** (MPI, Leipzig) and **Jennifer Smith** (Washington University), they are quite similar to tools that have been found at many different sites in sub-Saharan Africa (Ethiopia, Kenya, South Africa, etc.). They are classified as Middle Stone Age.

It is remarkable to note that the source of the stones used to make the tools was not in the site's immediate surroundings. Almost no unworked stone cores were found. It therefore seems that the Irhoud humans

made their tools elsewhere, and simply put finishing touches on them, or sharpened them, at the site. According to further investigation, the flint for the tools was mined at two different locations, over 30 kilometres from the Jebel Irhoud site.

Clearly, the animal fossils that were found were mainly the remains of the game hunted and eaten by the humans at Irhoud. **Teresa Steele** (University of California Davis) has studied them with an electron microscope, and identified traces of carving on the long bones, and signs that they were broken to extract and eat the marrow.

Irhoud humans were thus efficient hunters, and loved to dine on gazelles and ostrich eggs.

Moreover, researchers also found traces of hearths in the same layer as the human fossils. These findings yielded fire-heated flint artifacts. Burnt flint is a substance that is extremely valuable for dating procedures.

Daniel Richter, an expert in dating at the Max Planck Institute in Leipzig, Germany:

"Well dated sites of this age are exceptionally rare in Africa, but we were fortunate that so many of the Jebel Irhoud flint artifacts had been heated in the past. This allowed us to apply thermoluminescence dating methods."

Over the ages, radioactivity in the sediments around crystalline structures like flint gradually increases the quantity of electrons they contain, and we now have laboratory equipment that can measure those increases.

Heat causes the release of these electrons in the form of light emission. In other words, by being exposed to the heat of the fire, the Jebel Irhoud flints were "zeroed out." On the basis of the electron charge they currently contain, Richter was able to estimate how long it had been since they were last exposed to a flame.

However, precise calibration is the key to measuring thermoluminescence. **Daniel Richter** placed 47 sensors in the layers of sediment on the site to measure the levels of ambient radioactivity over the course of a whole year.

In 2010, he got the first results of his TL dating. The news was a thunderbolt: Level 7 and the fossils it contained dated back 315,000 years, give or take 34,000.

Ben Ncer: "We could hardly believe it. We expected a very old date, but not one that was such a revolution! This dating had overwhelming implications."

50 years after its discovery, the skull found in Irhoud had become by far the oldest known representative of *Homo sapiens* on Earth.

The site gave us a new starting point for our understanding of our evolution.

C) Modern and archaic

At the Max Planck Institute in Leipzig, all of the precious fossil skulls were scanned in 3D (using tomography). Virtual reconstruction programs could then be applied, to produce images of missing or deformed parts.

The most spectacular work is the reconstruction of a complete skull of one of our first *H. sapiens* ancestors, yielded by the micrographic scanning of the various fossil fragments that were originally found.

Hublin and his team carried out statistical processing based on hundreds of 3D measurements. Their goal was to compare the shape of the faces of these early Jebel Irhoud humans to those of modern humans. The result they came up with indicates that the face of this 300,000-year-old person would not stand out in a crowd today.

On the other hand, the shape of the skull and the enormous teeth are archaic features. They are closer to the anatomy of *Homo erectus*, the species that gave rise to *H. sapiens*.

JJ Hublin: From an evolutionary viewpoint, this is a very important finding. It shows that the modern human face appeared much earlier than we imagined. Over the course of the hundreds of thousands of years that followed, adaptive evolution chiefly concerned the shape of the skull – and therefore, that of the brain.

ACT 2 - AFRICA: A new cradle, the size of the continent

Proof that these humans were present in northwest Africa 300,000 years ago drastically expands the geographic boundaries envisaged until now for the emergence of our species. The evidence forces us to re-think the Africa of our origins. A territory that has been largely underestimated must now be integrated: the Maghreb and the zone of the Sahara.

Moreover, Jebel Irhoud is not an isolated discovery.

A) North Africa, rediscovered

North Africa contains a large number of paleolithic sites.

However, most were discovered and excavated during or just after the colonial period. Mainly, they were interpreted on the basis of European chronologies. As a result, nearly all of them were plagued by the same problems as those which long masked the reality of Jebel Irhoud.

To correct the situation, a huge effort has been underway for the past three decades, especially in Morocco, where the Institute in Rabat was instrumental. The study and dating of these sites have been reviewed through the lens of modern perspectives; the data has been sifted with state-of-the-art tools.

Today, these researches establish continuous human occupation in North Africa during the crucial periods of emergence and development of *Homo sapiens*:

- Between 700,000 and 400,000 years ago, paleontologists have catalogued undeniable traces (i.e., bones and tools) belonging to the immediate predecessors of the Irhoud man at several sites in Morocco (Tighenif, Thomas Quarry 1 and 3, Salé, Sidi Abderrahmane, etc.).

- Also, new datings have been established for a large set of sites spread throughout the Sahara zone (over a surface area larger than the United States). They are characterized by stone tools classified as "Aterian" which are found only in North Africa.

In Morocco, such tools were found alongside the fossil remains of modern humans- And this Aterian period, once thought to have begun 40,000 years ago, at the very earliest, would actually date back as far as - 145,000 years. The sites attest to large populations of the Sahara zone over the whole period of the evolution of modern humans, between Irhoud and the great migration out of Africa.

Jean-Jacques Hublin:

"North Africa has yielded an extremely rich fossil series, recognized today as documenting human evolution between 700,000 and 40,000 years ago.

"It is now obvious that this region has a primordial role to play in our understanding of the appearance and evolution of *H. sapiens*, certainly as important as that of sub-Saharan Africa."

B) The African continuity

Today, North Africa is separated from the rest of the continent by the planet's largest desert, the Sahara. This zone constitutes a natural barrier that is nearly impossible to cross. But we are gradually coming to the realization that things have not always been this way:

Teresa Steele has carried out advanced comparative analyses of animal bone fossils uncovered in northwestern and southern Africa.

Her findings impart a vision of the landscape around Irhoud as an open savannah or grassland that hosted a great diversity of animal species: gazelles, zebras, gnus, antelopes, and buffalo, preyed upon by leopards, as well as some lions. There were also smaller felines. The setting might resemble that of today's Serengeti region, in Tanzania.

"On the whole, the fauna is fairly similar to that of eastern and southern Africa. Many species are common to both regions, as are nearly all of the genera. As a result, it is clear that animals migrated freely from northwestern Africa to the rest of the continent, and vice-versa, implying the absence of a continuous Saharan barrier."

This image is corroborated by findings about the Saharan paleoclimate, through research carried out in recent decades (**Jennifer Smith**, Washington University; **Nick Drake**, King's College London). Based on the analysis of data from core samples of marine sediments or continental deposits, these two researchers' models revealed a surprising fact: the Sahara did not become a permanent desert until fairly recently.

In the more remote past, the models attest to highly unstable monsoon phenomena in Africa. Many times in the past 2 million years, over periods lasting for thousands of years, abundant monsoon rains fell in areas much farther north than they do today. During those periods, North Africa experienced "Green Sahara" episodes, when it contained large rivers and lakes the size of Germany. Most of what is now the Sahara Desert was a savanna land; there were even wooded prairies in some parts. The whole African landmass, from north to south, was then a single territory, where animals and the first humans could travel without encountering barren lands.

C) The mark of *H. sapiens* throughout Africa

Furthermore, when finds recovered from sites in North Africa are compared with those from sub-Saharan Africa for the same eras, it is clear that the tools from Jebel Irhoud, like those from the Aterian sites, fit perfectly into the range of what is classified as Middle Stone Age in sub-Saharan Africa.

The oldest Middle Stone Age tools found in South Africa date back 290,000 years; those from east Africa, 280,000 years. However, so far, no one has uncovered human fossils connected to the tools.

Shannon McPherron: "Starting about 300,000 years ago, we observe an industry, a way of shaping stone tools, that is shared all over Africa. The dating of Irhoud makes it possible for us to associate the emergence of this industry with the very first specimens of humankind. This leads us to believe that this type of industry may be a mark specific to *Homo sapiens*."

We therefore have proof that the first *Homo sapiens* groups were present throughout Africa, dating at least as far back as 300,000 years ago.

ACT 3: THE BIRTH OF MODERN MAN

A) The evolution of modern morphology

We can now consider the whole of Africa, because the fossil series of the first specimens of *Homo sapiens* available to us originate from sites all over the continent: *Jebel Irhoud* in Morocco (-300,000 years), *Florisbad* in South Africa (-260,000 years), *Omo Kibish* in Ethiopia (-195 000 years), and Herto, also in Ethiopia (-160,000 years)

JJ Hublin carried out comparative 3D morphometric analysis on all of these first *H. sapiens* skulls to see whether they might correspond, and if considering them together might indicate a path or trajectory.

As for **Shara Bailey** (Department of Anthropology at New York University), she has developed advanced methods for the analysis of tooth structures as phylogenetic evolutionary markers, and applied these methods to the same set of samples.

Both approaches concluded that this evolution was extremely gradual. Here and there, characteristics maintained in modern human anatomy are found; other features are still archaic. But these features vary, depending on the individual.

This scattering suggests that our species underwent a complex evolutionary process all over Africa. The data, far from demonstrating separations typical of speciation, indicated an evolutionary model that was a mosaic of clusters.

Hublin: It occurred on the scale of the entire continent; in Africa, from north to south, great movements were underway between 350,000 and 55,000 years ago.

B) The emergence of modern behaviors

The findings at Irhoud change our vision of human evolution. It must be seen as gradual, fed by exchanges on the scale of the whole African land mass. Recent discoveries in the field of human behavior strengthen the hypothesis:

South Africa is known to have yielded the oldest traces of behavior that is classified as "modern." Blombos Cave, located 300 kilometres east of Cape Town, contains Middle Stone Age tools that have been dated back to 100,000 and 70,000 years ago. Sea-shell beads, blocks of ochre engraved with geometric patterns, and bone tools were found in the same deposits.

Since Blombos was discovered in the 1990s, however, excavations at El Mnasra (on the Moroccan Atlantic coast, near Dar es Soltane) have also yielded bone tools and proof of massive use of ochre pigment.

In the Aterian deposits at a neighboring site, Taforalt, recently redated to -100,000 years, shell beads were also discovered. Like the ones from Blombos Cave, they are made from Nassarius whelks. And they are probably somewhat older.

More amazing yet, this early whelk jewelry has been found in Qafzeh, Israel. It has been dated to 100,000 years ago. Qafzeh is the site that has yielded the oldest evidence of *H. sapiens* outside Africa.

JJ Hublin: "The outlines emerging indicate that the continent was the setting for exchanges over huge distances. It is rather incredible to observe that humans living in both Morocco and South Africa used exactly the same type of shell to make this jewelry. Could they have traded them?"

C) Migratory populations

Paleoclimatologists' models suggest that there were key monsoon fluctuations between 350,000 and 50,000 years ago, creating the "Green Sahara" phenomena.

Juan Cruz Larrasoana (Instituto Geologico y Minero de Espana, Universidad de Zaragoza);

"The climate and environment reconstitutions we were able to do for North Africa suggest that there was a cluster of green episodes occurring every 100,000 years or so. The periods of highest rainfall can be observed about 315,000, 215,000, and 115,000 years ago. Within these clusters, green episodes lasting from 5,000 to 10,000 years alternate with arid times that lasted from 10,000 to 15,000 years."

For thousands of years, grasslands covered North Africa, making it possible for humans and animals to settle there for hundreds of generations. During those times, migratory exchanges could take place with the rest of Africa. Then the land would gradually dry out, leading to the formation of a desert. Animals would seek greener pastures, and the hunter-gatherers would follow them.

The Stone Age population of North Africa seems to have ebbed and flowed according to these climate changes. It developed over broad areas during green episodes. When rainfall became scarce for centuries, early humans gathered around oases, and migrated to coastal zones, or south to sub-Saharan Africa.

Juan Cruz Larrasoana: "Actually, the majority of the African hunter-gatherer populations probably migrated this way, following the game, seeking the grassland environment where life could flourish. The central African forest belt was also subject to occasional drought. When monsoon rains did not fall, it contracted. The Kalahari Desert also seems to have varied as a consequence of these fluctuations.

"Climate events sometimes isolated populations for hundreds of generations. When they were reversed, and the environment changed with them, humans and animals migrated. Human beings were forced to adapt to different conditions. The weather caused population flows and exchanges throughout Africa. These events may even have played an essential role in various migrations out of Africa."

JJ Hublin: "We must picture populations on the move all over a gigantic continent (and perhaps sometimes around it) over evolutionary time. As these peoples flowed, they may have exchanged genes, behaviors, and means of adaptation.

This is why the search for a specific point of origin has never been logical in itself. The little evidence available to us will never be enough for us to reconstruct evolution in such minute detail.

However, we do have more and more clues to mapping population flows."

D) Evolution of the human brain

It is time to examine the evolutionary advantages that were selected over the course of these 300,000 years, making us the humans we are today.

The tools that are currently available to us can extract hitherto inaccessible information from fossil remains. 3D scans of skulls are the first step in producing extremely precise molds of the inside of the skull. This mold is called an "endocast." The inside of the skull yields a 3-dimensional model of the shape of the brain.

In Leipzig, **Simon Neubauer, Philippe Gunz, and J.J. Hublin** carried out extensive comparisons of the evolution of these endocasts in a variety of species, including *Homo sapiens*.

Simon Neubauer: "Irhoud provides us with a new and more complete starting point, precisely dated, from which to compare other fossils. Now we can learn more about the evolutionary path of the human brain within the *H. sapiens* species. Likewise, it teaches us about the brains of extinct family members like the Neanderthals."

The same phenomenon is observed in both *H. sapiens* and the Neanderthals. The brain evolved constantly. There are considerable differences between the brain anatomy of the first *H. sapiens* and modern humans. But anatomical evolution obeys a variety of mechanisms. Our singularity resides in such mechanisms. When did we become who we are?

The results of this study (still under embargo) are scheduled to be published soon in *Nature*.

CONCLUSION

The discovery of Irhoud overturned all earlier scientific certainties about the origin of our species. It opened new horizons and upset the paradigms.

Paleontologists researching the dawn of humankind usually seek a single starting point: a sudden separation or emergence, a single evolutionary leap. Irhoud conjures up an image of continuity, gradual mixing, and shifting borders. It is a much more complex and subtle picture in which climate and environment played a primordial role in accelerating evolution.

Yet at the same time, Irhoud gives today's scientists the oldest and most reliable landmark date in the history of our species, a point from which we can re-think our evolutionary journey. The findings expand the horizons for investigation to the whole African continent. New visions of our ancestry are in store.