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Yves Coppens, Evolution and Mozart

Colloque In Memoriam Y. Coppens de l'Association
des Géologues du Sancerrois, 14-16 avril 2023,
18300 Crézancy-en-Sancerre, France

Yves Coppens (1934-2022), the most well-known faces of French research, passed on his knowledge as a paleoanthropologist to us after discovering the great prehistoric sites which provided him with the necessary evidence to question the mechanisms of change in characteristics of hominids. He hypothesized evolutionary drivers that include environmental, dietary and tool use factors. In 1976, his rise to the higher levels of education became historic with the exhibition "Origines de l'Homme" at the Musée de l'Homme in Paris.

At the time, the (H)Omo event had already made his reputation with the demonstration of the emergence of the genera *Paranthropus* and *Homo* which strided the same climatic phenomenon which shares the tall grass savannah with the short grass steppe. But none, except Donald Johanson, made so much noise with the description of *Australopithecus afarensis* and especially with the skeleton of Lucy found in 1974 and described in 1978. He has evoked in 2022, through his last work "A Memory of Mammoth", a certain number of scientists who met within the "Association of Geologists of Sancerrois" in France. This article covers some of our discussions about teeth and skulls from over 4 million years ago up to Mozart.

Introduction

Fabulous and fascinating, Yves Coppens is so in more ways than one. If I have the opportunity today to speak to you about Professor Coppens, it is because he has contributed effectively to developing cooperation between researchers. Here is what I am indebted to him for. To talk to you about the Art and the way of Yves Coppens I had to choose among its different sides so as not to go too long, I chose the Palaeontologist. The one who picked up and collected the fossils on the surface of the soil before they were lost, because they were transformed into sand by water and wind. Palaeontologist, one who studies the ancient life of animals and plants by searching the earth for their fossilized remains. Palaeontology is not Archaeology. This Science is partly based on the discoveries made by amateurs.

When Yves Coppens searched the cliffs of his Brittany, it was to discover treasures from the past, but also to fuel a creative imagination: he wondered what is underground. This passion that we share makes Palaeontology a science of participa-

tion open to all. Many curious people have also scanned the ground in search of the preserved trace of ancient men and to call what we have not been experienced. Yves Coppens, from an early age, sought in this way the traces of the prehistoric and their activity as some of us have done and it is in his search for the meaning to be given to make the past speak that we are followers of his thought and that we claim his heritage. This is obviously how we are “Coppensiens”, by mark of filiation. Let us add that if the distinctions marked out the career of Yves Coppens, the importance of these was located after the particular place that the meetings occupied for him. The purpose of this communication is to bring together some of these encounters.

The itinerary of skull and dental moments began in 1959.

At the age of eighteen, that is to say in 1959, I became aware of the existence of the pre-human named “Zinj” (old word for East Africa) or Olduvai Hominid 5 (OH 5). One cannot forget the mine of this fossil, which will be classified as *Paranthropus*, unearthed by Mary Leakey at Olduvai in Tanzania (figure 1). It had been preceded a few days earlier by a third left molar fixed in a piece of mandible: OH 4 described in 1964 as a paratype of *Homo habilis*. The habile man with smaller teeth, but to whom the tools unearthed on the site are attributed, suggesting the co-existence at Olduvai of two species of hominids. *Paranthropus* and *Homo habilis* having highly useful adaptative traits.

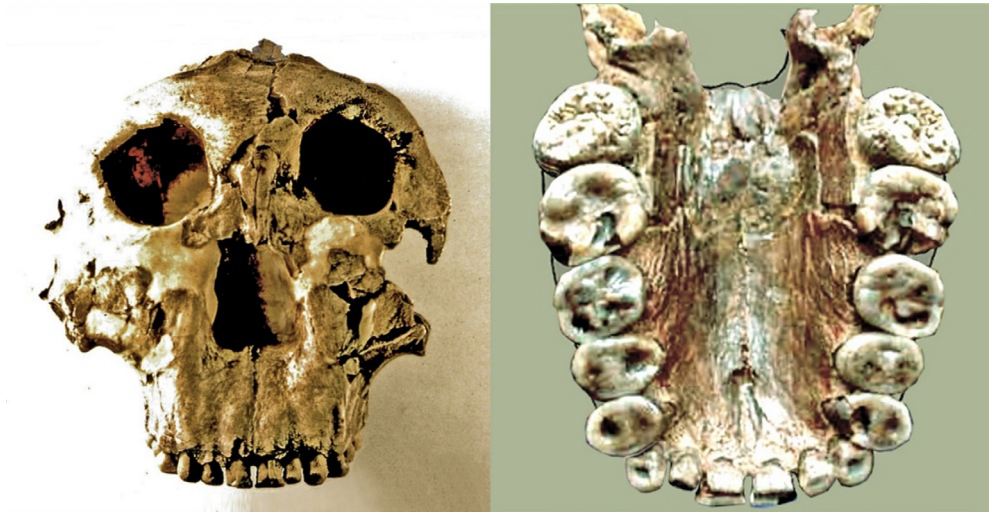


Figure 1. Skull of *Paranthropus boisei*, or *Australopithecus boisei* originally named *Zinjanthropus boisei*, about 1.8 million years old.

The OH5 skull is provided at its top with a bony crest on which are anchored the temporal muscles of mastication which actuate very heavy jaws. The molars and premolars, four times larger than ours, give the certainty that our distant ancestors were on earth to chew for a long time having enough enamel to wear down. This discovery, by transporting me from the vision of the present world to a strange and fascinating past universe, has most certainly guided my university career towards the study of morphogenesis. That is to say: why have we become as we are.

Yves Coppens, for his part, CNRS research associate since 1956, then studied elephants in the laboratory of the Faculty of Sciences of Paris (the Sorbonne) and was mounting the fossil bones of a mammoth for the Gallery of the Museum.

In 1959, researcher in the laboratory of the Institute of Palaeontology of the National Museum of Natural History under the direction of Abbé René Lavocat, he was responsible for preparing the fossils sent by Jacques Bardeau and Jacques Abadie hydrogeologists from the Equatorial Institute to North Chad. He is particularly interested in the evolution of the fossil teeth of elephants and does research about paleontological sites which include vertebrates and in particular - elephants, rhinos, horses, hippopotamuses, and large carnivores - which allow him to propose a dating of the site. The teeth of the elephant are easily read thanks to the number of ivory blades that compose them and the enamel that covers them. The *Equus* horse appears in East Africa two million years ago, it does not have an ectostyle: the small cusp of the lower teeth of the three-million-year-old hipparion, however, the *Hipparion* and *Equus* coexisted in Africa for more than 1.5 Ma and are of great importance for the understanding of ancient climate changes. We see that Yves Coppens had food for thought about the morphological “transformations” which did not always evolve jointly and synchronously. He most certainly wondered if the soil of Chad, whose fossilized bones he classified in the Museum, housed some ancestors of *Homo sapiens*. He left for the field in January 1960 and Africa would be the big deal for the palaeoanthropologist.

For my part, my knowledge of the prehistory of man deepened with the paleontological publications of the 60s. First “The Evolution of Man” by G.H. Ralph von Koenigswald published in 1962. There he presents the gradual evolution towards Modern man in a simplified way through *Australopithecus*, *Homo erectus*, *Neanderthal* and *Homo sapiens*. Second “Early Man” by Francis Clark Howell, one plate of which illustrates the path of traits to modern man *Homo sapiens* (figure 2). For convenience, I keep the four presented stages of our evolution to evoke my meetings with Yves Coppens which relate to 4 million years, of the *Australopithecus* of Garusi included in the identity of *Australopithecus afarensis*, but preserving a primitive facial character of *Australopithecus anamensis*, down to modern times 250 years ago with Mozart’s skull.



Figure 2. The four stages of human evolution and the iconic representation of character evolution illustrated in 1965 in Clark Howell's book. A man's geometry defines performances. Note that man is characterized by a large brain compared to the size of the body.

Use of teeth by Hominins

Let's come to the scientific methods used to tell evolution with the support of Yves Coppens for whom the tooth says a lot of things.

Once a dental surgeon, I continued my studies and undertook research in faculty because of the creation of the Doctorate in Odontological Sciences then opened up the Anthropology and Palaeontology laboratories to dental surgeons. This research focused on the shape of teeth, which changes over time and according to species. The contrast of the dental dimensions which exists between the robust australopithecines and those of the *Homo* lineage, led me to develop specialized research which I presented in a congress at Nice in 1976. It was a question of setting up a method of analysis of the wear of the teeth whose alterations reflect their use and Henry de Lumley then asked me to present the first results in a few pages of "La Préhistoire Française" published in three volumes by the National Center for Scientific Research (CNRS). The book became the basis of any bibliography on the prehistory of our country, and I learned later that this congress had brought together three thousand five hundred participants. It was in Nice, after having presented orally the comparative study of the wear of the teeth of individuals with different diets, that Yves Coppens came to see me to ask me to join him in the anthropological study at the Museum of Man.

He subsequently supported me in various research, if only by making available to me the osteological collection of more than 18,000 skulls, some of which belong to famous people (Descartes, Pascal...). These skulls are kept in the anthropology laboratory of the Palais du Trocadéro in Paris.

This is how my encounters with Yves Coppens took place during congresses, symposiums or in the laboratory.

The (H)Omo event made Yves Coppens famous

In the Omo lower valley in Ethiopia Yves Coppens searched, in the company of Clark Howell, the emergence of the *Homo* genus and that of the robust *Australopithecus*, as Leakey had done at Olduvai in 1959 (figure 3). The expedition is international according to the will of the Emperor Hailé Selassié. Established under the patronage of the Ethiopian Institute of Archaeology in Addis Ababa in 1967 by Yves Coppens who assists Camille Arambourg and Richard Leakey with the help of Clark Howell (figure 4).

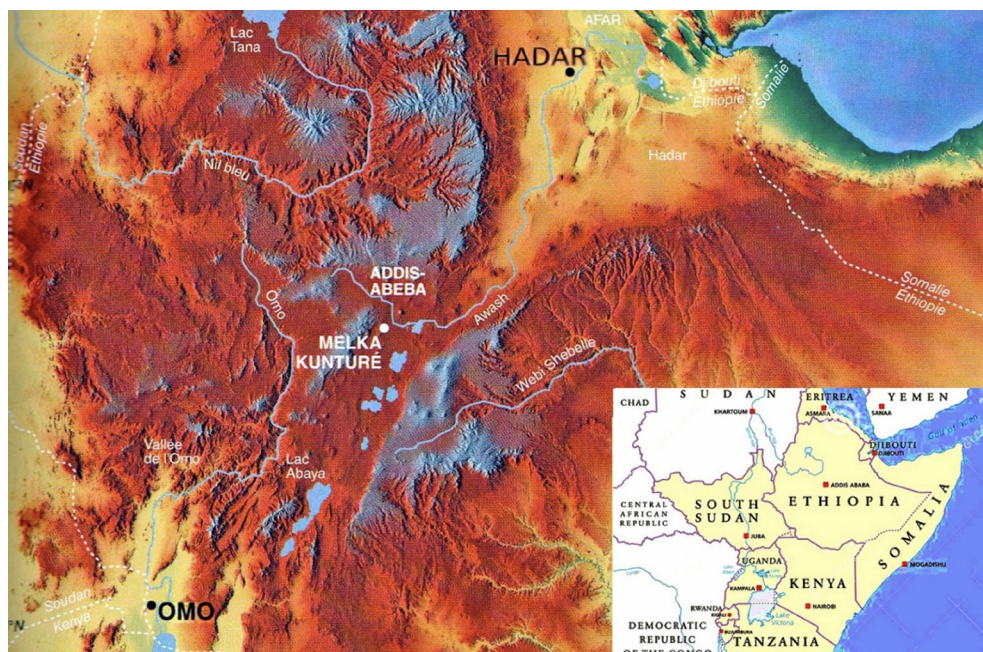


Figure 3. Map of East Africa with the valleys of the Awash and Omo rivers as well as the Omo and Hadar sites. Thanks to the Omo and Hadar sites, researchers have a quantity of *Australopithecus* bones. In Omo and Hadar, the sedimentary layer of several hundred meters thick preserves the history of Australopithecines from around 1.8 million to 3.5 million years ago. The annual rains have exposed hundreds of fossils, dozens of individual hominids. This library of fossils allows researchers to make crucial comparative analyses. © after Giacomo Corti.



Figure 4. Camille Arambourg (1885 – 1969) and Yves Coppens (1934 – 2022) in the Lower Omo Valley in 1968 © Raymonde Bonnefille.

It should be remembered that Clark Howell introduced Omo researchers to new multidisciplinary practices in palaeoanthropology. At the end of the 1967 field season, Arambourg and Coppens gave a preventive press conference announcing the discovery of a robust shaped *Australopithecus* jaw (*Paranthropus*).

The joint action was determining by the conjugation of the specialists to exploit the ground of the period located between minus 1.8 and 3.5 Ma. This time interval is exceptional by its climatic aridity associated with the presence of robust *Australopithecus* provided powerful teeth at the same time as *Homo* with more reduced teeth and more voluminous encephalon than that of the Australopithecines. At 2.8 Ma, tropical aridity is documented by fauna and flora, then around 2.5 Ma, following an increase in the Arctic ice cap, cold is observed in temperate countries and tropical drought in Africa from the East with a drop in the percentage of tree pollen.

The archaeological life of Yves Coppens at the Omo, where he exhumed a number of fossils and collected environmental clues delivered during the excavations, was not known to me at the time. It is through the work that takes place after the fossil bones and teeth have been brought into the laboratory that I have been concerned, in particular with the Shungura formation of the Omo which gave a skull of *Homo habilis* 1.8 million years old (specimen L.894-1), of which a premolar bears the trace of the toothpick under the shape of a groove and a robust 2.4 million year old *Paranthropus* or *Australopithecus* whose mandible takes on the V-shape at the incisal level (OMO 18-1967-18). From what Yves Coppens calls the (H)Omo event emerges the genera *Paranthropus* and *Homo* which prospered during the same climatic phenom-

enon. The analysis of dental traits provides specific information on functional roles.

If research in the Omo lower valley was initiated by Camille Arambourg with Francis Clark Howell of the University of Chicago and then of Berkeley, Yves Coppens found himself in the cases of the Omo and the Awash accompanied by the anthropologist Donald Johanson and Raymonde Bonnefille responsible for reconstructing the constant changes in the environment using fossil plants and thus completing the information given by the animals (figure 5). The vast plain where the Omo River spreads out its meanders, before flowing into Lake Turkana, is covered with an acacia savannah and surrounded by volcanic massifs, some of which are very young. The Omo river suggests that East Africa has immense potential and Ethiopia is understood to be unique in human history. Raymonde Bonnefille and Yves Coppens have soon after participated in setting up the excavations of the lower Awash valley in Hadar, the land of the Afars, with Maurice Taieb (Bonnefille, 2018). In 1968, Richard Leakey continued research on the shores of Lake Turkana and over the next four seasons recovered 49 fossil hominids, 13 more than Louis and Mary had found in 36 years at Olduvai.



Figure 5. A special morning for Raymonde Bonnefille, 2018 page 227. White sands, Omo locality 840. F. Clark Howell, Don Johanson, Raymonde Bonnefille, Jean de Heinzelin. 1972. Photo H. Wesselman.

Neanderthal teeth and dental arcades placed forward.

Located on the Old Port of Marseille, the iconic “New York” brasserie, which has now disappeared, faced the quays and gave, with its dark floor with wide slats, the relaxed and friendly atmosphere that we imagine for the ideal meeting place for beer lovers. The waiter served them to us with small pizzas. You can guess the effect produced on me by the arrival of the paleoanthropologist director of anthropology at the Musée de l’Homme who had come down from Paris so that we could join Raymonde Bonnefille and the geologist Maurice Taieb, both at the University of Marseilles-Luminy. It was for me a question of joining the French “East Africa” team which was preparing a joint research program with D. C. Johanson (Cleveland).

If for Raymonde Bonnefille it was about the reconstruction of the paleoenvironments, even the paleoclimates of Hadar (Bonnefille, 2010), my studies concerned the teeth of hominids and their wear examined under the microscope. Yves Coppens was the French researcher who had the privilege of recognizing the succession of evolutionary stages of man. He was going to help me compare the fossil teeth tracing this evolution, ranging from *Australopithecus* to *Homo habilis*, *Homo erectus*, *Homo neanderthalensis* and *Homo sapiens*. My research aimed at determining the mechanical nature involved in hominid chewing in relation to food, and therefore to the environment.

I am currently working on abrasion typology for *Homo sapiens* and have next to continue with neanderthal man as it has been shown that there is a direct relationship between jaw mechanics and microscopic aspects of wear teeth (Puech 1978, Rensberger 1978, Walker 1979), it is therefore possible to test the dietary hypothesis proposed for *Neanderthal* by examining his teeth. The examination of subjects whose environment and living conditions have been previously studied, as is then the case for neanderthals, aims to clarify the origin of individual characters and to study the functional significance of the morphology derived from use. Yves Coppens has given me the opportunity to analyse the two adult neanderthals from La Ferrassie kept in his laboratory in Paris. Adults from La Ferrassie (- 40,000 years) have a particular facial region developed into a “snout” specific to Neanderthals (figure 6).

The teeth are thus brought further forward than for any other fossil human during evolution. As a result, the mandible is long, longer than the very primitive one of Mauer’s *Homo erectus*, which is more than 500,000 years old. This study was entrusted to me by Yves Coppens and prepares me for the morphological and physiological diversity of the dental arcades which is one of the characteristics of our *Australopithecus* predecessors.

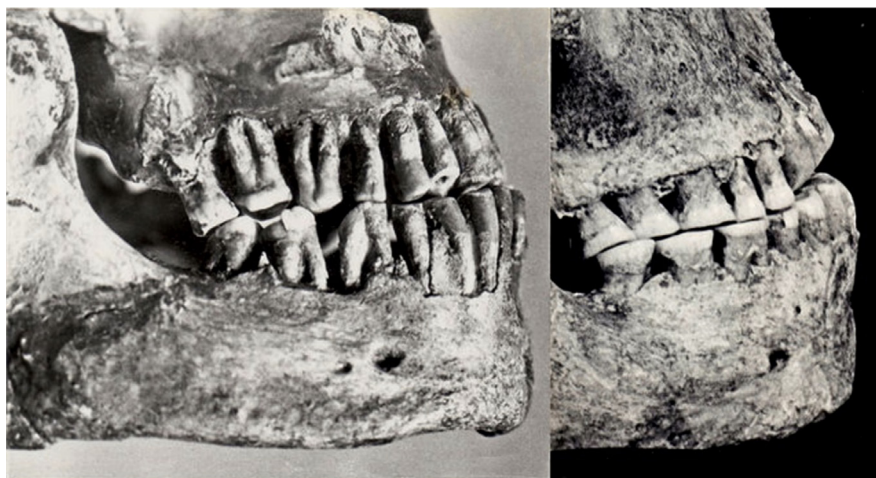


Figure 6. The dental occlusal position of La Ferrassie and Shanidar men (60 to 80,000 years ago) is determined by the same dental wear model. Note the labial rounding of the upper incisors while the premolars and molars are worn flat. © Puech P.-F. and Trinkaus E.

***Australopithecines afarensis* - numerous and diverse: 300 individuals in 500 fragments.**

The comparison of the teeth and jaws of the group of australopithecines fossils present at the museum of Addis Ababa, capital of Ethiopia, was to verify the unity of the species of *Australopithecus afarensis* (Johanson et al., 1978). For this, on March 21, 1980, a request had been made to the Ministry of Culture of Ethiopia, under cover of the Cultural Counselor of the Embassy of France in Ethiopia, in order to carry out research on the teeth of hominids from the Afar region (figures 7 and 8). I had acquired a particular interest in the application of dental examination to solve phylogenetic problems in addition to researching the distribution of characteristic micro-striae of teeth in relation to diet.

Let us recall that on January 29, 1980, Maurice Taieb and Donald Johanson had handed over the collection of 350 bones of Hadar hominids.

On April 1981 I was at Nairobi (Kenya) for the Laetoli hominids and on December 25, 1981 present in Addis at the Ethiopian National Museum, I met Tadessa Terfa, director of The cultural heritage. The museum is located in an old Italian palace, it originated from the Institute of Archeology founded in 1958. On Friday January 2, 1982, replicas, measurements and notes were made. It was a question of taking into account the diversity of the teeth and the dental arches and the general mode of flat wear of the occlusal surfaces of the teeth with a shiny blunting and the wear of the dentin which predominates giving islands of depressions. The importance of

the shape of the tooth crown refers to the question of how specific morphological characteristics have evolved to adapt (Puech et al., 1983; Puech, 1986). For *Australopithecus*, the premolar and molar teeth increase in volume from the front towards the back of the mouth, whereas nowadays the first molar is more massive than the other molars (figures 7 and 8). The results of this 1981-1982 mission in Ethiopia was to be presented to the Collège de France in 1986.

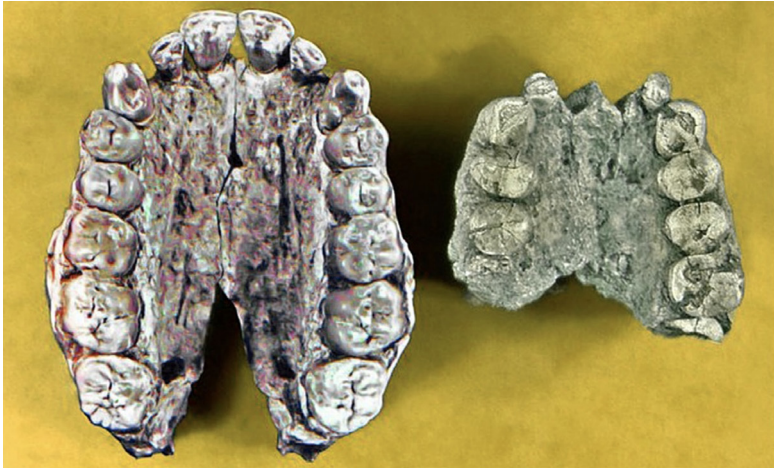


Figure 7. Diversity of morphologies of the maxillae of *Australopithecus afarensis* © P.-F. Puech.

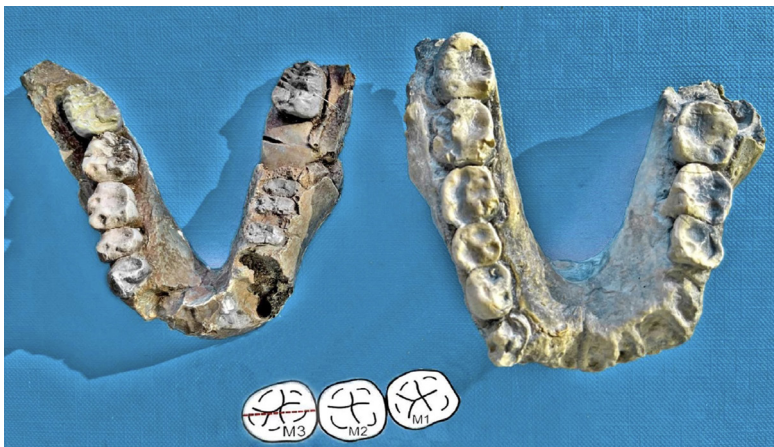


Figure 8. *Australopithecus afarensis* AL 288-1 woman named «Lucy»; Laetoli Hominid 4 LH 4: 3.6 million years © Pierre- François PUECH.

The professor of the Collège de France is master of his chair, he has only one obligation to deal with a new subject each year in eighteen lessons. Yves Coppens, who took over from Leroi-Gourhan (1911-1986) at the Collège de France, proposed for 1985-1986 to make us understand the importance of the discoveries made in Africa concerning Early man. Palaeoanthropology has continued to bring new elements to stage the life of our ancestors and it was necessary to specify the numerous informations collected on the oldest Hominids and to give an eco-geographical scenario of the origin of Man separated from the branch which leads to the great apes for more than 7 million years. The course was given on Tuesdays at 11 a.m., room 8 from December 10, 1985 to March 11, 1986. The same 375-seat room where Albert Einstein had come to speak with his extremely modest little voice about the elastic behavior of Time.

The public, on March 4, 1986, was the one attached to the only word of the enchanter Yves Coppens and as André Gillois specified, “we were queuing to enter the small room n° 8 as if to go to the cinema” . This Tuesday at 11 a.m. Yves Coppens entered behind an usher whom I was accompanying. Indeed Yves Coppens who encouraged academic mobility had invited some of us (Michel Sakka, Philippe Brenot, Christine Tardieu, Christine Berge, Brigitte Senut, Roger Saban, Pierre-François Puech and Yvette Deloison) to describe the first course of the history of Man, the subject of the courses at the College for the academic year 1985-1986.



Figure 9. *Australopithecus afarensis* cerebral capacity 340 cm³. The *afarensis* Lucy observes us from the shore of a lake © Pierre-François Puech and Viktor Deak courtesy of Ian Tattersall.

My presence in these places and this world, quite exceptional where the character of the moment was Yves Coppens, leads me to tell the how of my research on the “Wear and uses of the teeth of Hominids”. In the introduction, Yves Coppens recalled the discovery of the first humans, *Homo habilis*, made by Louis and Mary Leakey at Olduvai in Tanzania near a very robust *Australopithecus*, the *Paranthropus* “Zinj”. I then began by recalling that teeth are the only fossil remains that were in direct contact with the envi-

ronment of our ancestors and especially with their food. By analysing the dental enamel under a scanning electron microscope, differences in the use of the teeth to reduce food are highlighted from the orientation, length and frequency of the cutmarks according to a very precise methodology (Puech and Pinilla, 2014). For *Australopithecus afarensis*, dated between 2.9 and 3.9 million years ago, the reduction in the maxillary canine projection gave more margin in the occlusion of the teeth and transformed the function. Teeth with rounded or conical cusps protected by thick enamel coverage and highly developed premolars and molars are attributes associated with the grinding of food by the various pre-human and human species. An aspect that could also result from the way certain foods were prepared in the mouth. For example, by chewing for a long time to extract the juice before rejecting the fibrous or sinewy chewing and tough food.

Homo erectus: a large database of 32 individuals at Tautavel, France.

Yves Coppens considered Tautavel in the south of France to be one of the main sites of prehistory, in the same way as those of Ethiopia or Zhoukoudian in China. It is time to find him in the company of Henri Gastaut (1915 -1995) sitting in the shade of the “Café de la Place” run by Albert Pla (1929 - 2008). This lover of ancient human skulls, from Oceania and America, sculpted, painted, over-modeled or even engraved, takes advantage of the shade of the mulberry-plane trees spread out where the academicians Jean Piveteau took turns over the years, Jean-Pierre Lehman, Jean Dausset, Jean Dorst, André Leroi-Gourhan, but also the famous discoverers of the australopithecines of East Africa: Francis Clark Howell, Donald Johanson, Maurice Taieb, Mary Leakey, Richard Leakey. It is a little over 3 kilometres north of the village that we find the Caune (cave) of Arago perched on the side of a cliff. It is in the latter that Tautavel Man was unearthed, a general term which designates 32 individuals including 18 adults, 1 teenager and 13 children. The skull of a 25-year-old man, Arago 21, was found among the culinary remains bearing consumer marks. This fractured skull, which looks like a mask, gives us the portrait of the oldest Frenchman half a million years old (Figure 11).



Figure 10. Mandibule *Australopithecus afarensis* AL 400-1a (3,3 – 3,5 Ma) unearthed personally by Maurice Taieb on December 4, 1976 on the indications of a young Afar. © Maurice Taieb and Pierre-François Puech.

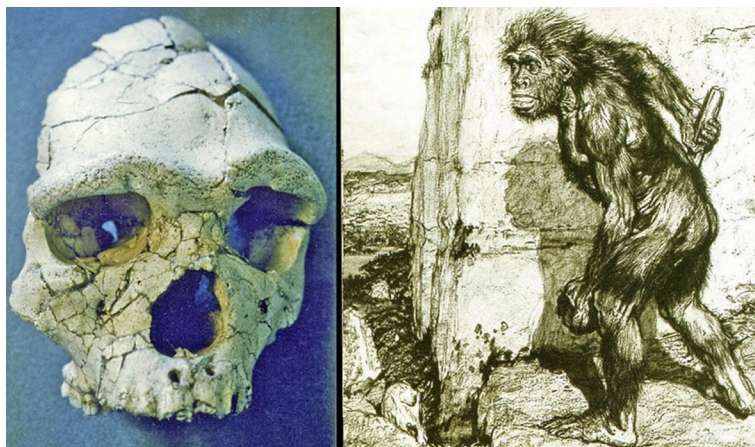


Figure 11. Arago XXI, discovered on July 22, 1971. The low skull has a large frontal extension, a very prognathic face and marked temporal crests in relation to a powerful masticatory apparatus as represented for Eugène Dubois' *Pithecanthropus*. Drawing by F. Kupka under the direction of Marcel Boule

Yves Coppens came to Tautavel on the occasion of the main discoveries or for their anniversaries at the base camp of the diggers, on the left bank of the Verdoubert, to then climb 80 meters higher and enter the Caune de l' Arago oriented to the west. He thus shared with researchers his historical vision of human existence acquired by trying to understand the past using all the means of analysis given. The identity of the men of Tautavel was for him that of very first pre-neanderthals whereas we had following the observations of Marie-Antoinette de Lumley adopted the fact that it was about an ante neanderthals who was named *Homo tautavelensis*. In the 'Drops of Science' disseminated by Yves Coppens, he specifies that the drift of *Homo erectus* from Africa is undoubtedly the line of prehistoric man who has been most talked about.

Thus the Tautavel Man allowed me to get to know Yves Coppens in the field and to photograph him. This photographic point of view at a short distance, like the previous one in the company of Camille Arambourg in the lower Omo valley, offers a supplement, by the motif and the atmosphere, to these moments in the history of human Palaeontology. Yves Coppens then assiduously frequented the professors at the Museum of Paris and always wanted to be a good friend. This gave his surroundings a certain very pleasant atmosphere. This character, out of the ordinary through paleontological exploits in Africa, thus appeared as an Academician Aspirant, which made him more accessible to the other Aspirant that I was then. Even if the level was far from being the same for the laboratory director in Paris compared to the student from Marseille preparing his thesis. He wore a beard and that day sandals. He was completely in his place in the company of Jean Dorst and Jean-Pierre Lehman, who had come at the invitation of Henry and Marie-Antoinette de Lumley. The outfit

adopted was that of the moment in the heat which had brought down the jacket, the white shirt and dark trousers being a far cry from the safari shirt and the khaki “officer of the Indies” trousers. There was then no tension and I decided to capture an image of him, but not just any image. I needed his person and the chance of the moment meant that there were four characters on the picture with very different attitudes to animate the painting (Figure 12).



Figure 12. Jean-Pierre Lehman, Yves Coppens, Albert Pla and Henry de Lumley at the Tautavel excavation camp © Pierre-François Puech.

A few years before, Yves Coppens in 1980 on the occasion of an article published in April in the journal *Nature* had revived in a poetic way, by lingering on the reconstructed landscape, the men of prehistory about “people du lac” at the end of the Lower Omo Valley more than a million years ago. Well here, the majority of the remains of the Tautavel Man unearthed were in sets mixed with the waste of animals having lived in a steppe, cold and windy environment. To bring out the singularity of this Man due to his position in the human lineage but also to the geographical and climatic situation, we compared the wear of the dental surfaces of Tautavel to that of a *Homo erectus* from Mauer (figure 13). This in an attempt to reconstruct the ancient man’s way of life.

The methods of study concerning the relationship -dental wear / dietary preferences- consist in deducing the functional aspect by considering an action of use of the teeth through the microscopic characters of the scratches produced on the buccal surfaces by the abrasive particles contained in the food bolus in relation to movements during mastication (Puech, 1976a; Puech, 1976b). The density and dimensions of the micro-striae are grouped according to four orientations: horizontal; vertical; oblique 45° backwards and oblique 45° forwards. The whole forming what we have called the “pattern” of the buccal striae (Puech and Pinilla, 2014). In the same way we compared different *Homo erectus* with each other like Peking Man.

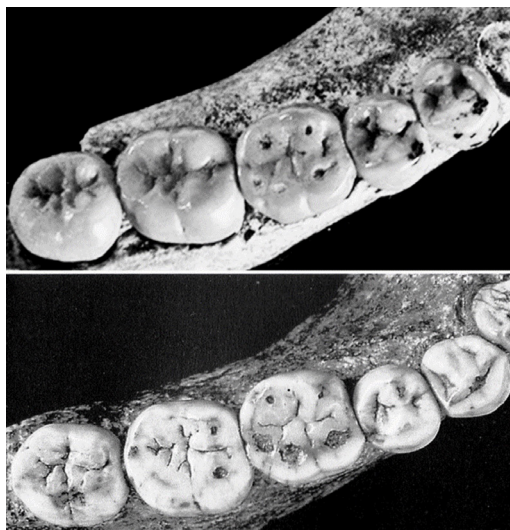


Figure 13. The great similarity of the teeth of Arago 13 and Mauer © Pierre-François Puech.

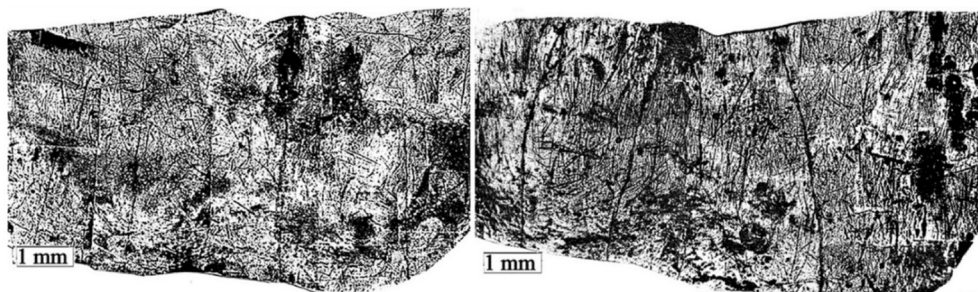


Figure 14. Assembled macrophotographs of the buccal surfaces of lower molars from Mauer on the left and from Tautavel on the right. The density of the striations is higher for the latter, while fewer horizontal striae are observed than for Mauer.

The functional characteristics of the teeth of *Homo erectus tautavelensis* differ from those of *Homo heidelbergensis* of Mauer, which reflects a different choice of foods that could be related to the environment (figure 14). On the other hand, the examination of the striae of a tooth of *Homo erectus* from Zhoukoudian shows an aspect of the striae very comparable to that of Tautavel with a high density of the striae and a small quantity of horizontal striae. The presence, near Mauer Man, of hippos indicates that the average winter temperature was milder than today, deer and horses highlight a wooded landscape with open spaces (Wagner et al., 2011). Most of the human remains unearthed in the Arago cave come from soil made up of sand transported by the winds; the pollens reveal fluctuations between the forest and the

steppe, with alternating humid temperate periods and cold and dry periods (Renault-Miskovsky, 1981).

In the search for validity, it is necessary to find clues that give a path of knowledge. To highlight the particularity of the dental characteristics involved in the function of the jaws, we examined the variability of the thickness ratio of the lower lateral incisor I2 and that of the lower second molar M2 (Puech, 2000). This is the ratio between the bucco-lingual diameter of teeth I2 and M2 and this ratio distinguishes Tautavel Man from *Homo erectus* (fig.15). This confirms the presence of derived characters in Tautavel Man comparable to those of the Neanderthal lineage (Puech et al., 1995).

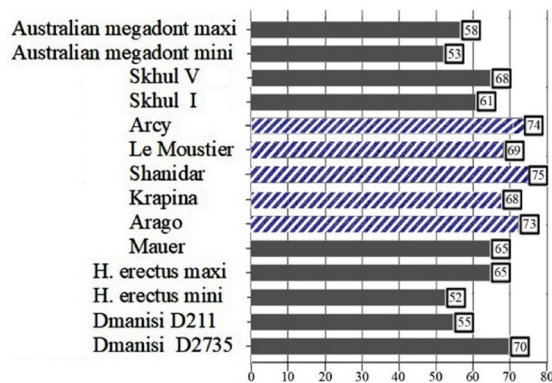


Figure 15. Anterior ratio (mandibular lateral incisor –I2) / posterior (lower second molar –M2) presented in the “35th Journal of Dental Research Annual Meeting September 23-25, 1999 Montpellier (Puech, 2001)”. Buccal-lingual diameter ratios of *H. erectus* n = 19 (from 0.52 to 0.65), *Neanderthal* n = 9 (from 0.65 to 0.75), the first anatomically modern humans of Skhül n = 2 (from 0.61 to 0.66) and robust present-day humans from Australia n = 600 (from 0.53 to 0.58), values measured by the author and Wolpoff (1982). Arago maxi for an individual 8-10 years old I2 A25=8.6mm and M2 A10=11.8mm i.e. 72.8.

The projection of the middle portion of the face of the ante-neanderthals of Tautavel and neanderthals is associated with a particularity of the dental arch, the *Neanderthal* incisors are robust, and the robustness of the posterior teeth is less than that of the *Homo erectus*, a presumably autapomorphic trait - a distinctive anatomical feature - is said to be a derived trait unique to a given terminal group (fig. 16).



Figure 16. Different projections of the mandible. That of Mauer (bottom right) is shorter than that of Arago XIII (left) and Arago II, whose rising branch is less wide (Mauer 52.5 Arago XIII 40 Arago II 48 measures M71 of Martin).

Our study of the microscopic striae of the buccal surfaces of the Arago teeth then offered us the possibility of deducing the food choice of Tautavel man by comparison with the striae of other populations with a known diet and of highlighting a micro dental wear corresponding to the food choice of this “opportunistic omnivore” man according to Yves Coppens (2020).

Mozart gracile skull form

The extension into the future of previous trends observed during evolution have led anatomists to propose the possibility that the gracilisation of the skull continues and is manifested by the obliteration of the superciliary arches and the lesser thickness of the skull (Olivier, 1964 ; Gibbons, 2014 ; Neubauer et al., 2018; Morell, 2023; Raviv et al., 2023). These characteristics observed on Mozart’s skull are such that the latter can appear as feminine, which led to a detailed study of this man “of the future” (figure 17).



Figure 17. *Homo sapiens* of 11,000 years ago. and Mozart 250 years. Greater supraorbital development, including an inflated glabella, rectangular orbits, more pronounced superciliary ridges and a depressed nasion, was a common feature in early Holocene. Humans have evolved retaining more youthful characteristics in adulthood than our ancestors. The skull of Mozart is large, domed with a large forehead, the reduced supraorbital margin is particularly diagnostic, and the rounded orbital cavities are located flush with the forehead © Pierre-François Puech.

Some measurements of Mozart's skull sign the peculiarities, such as the maximum and minimum width of the frontal bone and the height and width of the orbital cavity, compared to the average values of a population of Mozart's time from Berg, a small village in mountain near Greifenburg on the river Drau (Western Carinthia) near Bavaria, the region of Mozart's ancestors (figure 18). These identity traits result in part from dysmorphism due to early closure of the metopic suture and from a large cranial capacity. Berg's sample of male skulls from five generations was first described by Shapiro (1929). Berg represents, on the basis of historical and archaeological data, a culturally homogeneous community. At the time of data acquisition (1911) the village had only a hundred inhabitants.

	Mozart	Berg male (n= 55) *
Maximal frontal breadth	131	124.6
Minimum frontal breadth	97	99.6
Orbit breadth	36	40.1
Orbit height	33	33.7
Indice orbitaire	91,7	84

From Howells 1973

Figure 18. Identification of the frontal particularities of Mozart's skull by comparison with the average of a population of the region of his ancestors measured by Howells (1989).

Some values of width – height of the orbital cavities of the first human species: *Homo habilis* KNM-ER 1813 probably female aged 1.9 Ma and cranial capacity 510 cc: 34-30 and *Homo erectus* KNM-ER 3733 female aged 1.8 Ma and cranial capacity 850 cc: 43-34.

The “meetings” with Yves Coppens were an opportunity to discuss prehistoric teeth, things revolving around the shape of teeth and the function of mastication. Now it was necessary for Mozart’s skull to broaden the research to describe the very particular shape, so we created the association “Mozart 1791 - 1991”. Honorary President of the latter, Yves Coppens has never ceased to support this research, that concerning the various pre-humans or humans, for which he allowed me to go to East Africa, and that of modern man like those relating to Mozart in the case of his skull that Yves Coppens examined (Coppens, 2022). This explains why Eve Ruggieri, when she was about to conclude her “Dictionary of lovers of Mozart”, quoted a passage from the book “Pré-ludes” by Yves Coppens published in 2014, about an “extraordinary investigation concerning Mozart...”

Question: where does this investigation about Mozart’s skull come from? This skull came into the possession of the anatomist Joseph Hyrtl (1810-1894) who confirmed its identity with ink on the skull and added on the right temporal fossa: “Musa vetat mori” (Trötzmüller, Mödling Museum). History says that Wolfgang Amadeus Mozart, died at the age of 35, was buried in 1791 in an unmarked grave in Vienna. Thieves removed his skull which came into the possession of Joseph’s brother, Jacob. Jacob Hyrtl ceded it to his brother in 1868. The skull (figure 19) was deposited in the Mozarteum in Salzburg in 1894 where it remains to this day (Engl, 1906; Mütter edu staff, 2016).

It was not until 1986, when the International Mozarteum Foundation was asked to design an exhibition on the life of Mozart and Salieri, that Mozart’s biography lost its legendary character and became scientific. The big project was initiated in Tokyo following the 1984 film *Amadeus* directed by Miloš Forman which won the Japan Academy Prize two years later. Mozart’s strange punk image had to be explained, and Mozart scholar Professor Bin Ebisawa and Mozarteum’s Rudolph Angermüller and Otto Biba requested the skull expertise (Angermüller et al., 2005). The historical evidence as well as the first results of the analyses were presented by Gottfried Tichy and Pierre-François Puech in 1987 at the International Congress for Forensic Medicine in Vancouver (Tichy and Puech, 1987) and the Suntory Museum in Tokyo showed March to May 1987 an “Amadeus Exhibition – Mozart and Salieri”.

“A bit in disbelief, we were in Salzburg, Paris and Tokyo going through airports, as we brought a skull in a duffel bag through security.” Reports Geneviève Geffray, librarian of the International Mozarteum Foundation (Angermüller, 2005 page 384).

However, a group of anthropologists, including Herbert Ullrich, found that “every characteristic of the skull suggested that it belonged to a woman” (U.S. Army. 2006). It was therefore necessary in addition to the History, kept south of Vienna in the Museum Mödling-Thonetschlössl [Joseph Hyrtl section - Mozart’s skull], that forensic anthropology certify this skull. The anthropological analysis were followed by genetic analyses, carried out in Vienna and in the USA, and these definitively established that this skull was that of a man aged around 25 to 40 years. So much for the science, now let’s see what this skull tells us about Mozart’s life.

The main identifying information is probably the fact that the skull shows that Mozart suffered a stroke about a year before his death. This is consistent with the headaches Mozart described during his last year of life and provides a further explanation for his untimely death. The bone fracture with signs of healing diagonally marks the left side (Fig. 19), with a clot imprint on the internal table of the parietal (Puech et al., 1991).

Yves Coppens accompanied me in this identification by agreeing to be a member of the “Mozart 1991” association in 1987 before deeming myself worthy in 1993 of an afterword written for the French edition of the book which proposes a new biography of Mozart thanks to the contributions of anthropology. The book was edited in English in 2019: “Mozart, Applied Anthropology Inquest”.

Yves Coppens resumes in 2014 the afterword about Mozart in “Pre-ludes around Prehistoric Man”, then in 2022 in “A Mammoth Memory” he returns to the dental misfortunes from which Mozart suffered in chapter 19 with “The Mozart’s skull -250 years”. Concerning the dental pain mentioned by Yves Coppens, their cause is highlighted by the radiography of the end of the roots which shows the infection (granuloma in black) caused by the very deep decay of the upper left first molar.



Figure 19. Left side fracture of Mozart’s skull and clot imprint on the internal table © Pierre-François Puech.



Figure 20. Mozart's upper maxillary teeth with decay of the left first molar and its apical bone infection© Pierre-François Puech.

Anthropology needs material witnesses, and in the case that concerns us it is a skull of historical character accompanied by the myth constructed by biographers. Now, rid of this 'aura' that surrounded the skull at the Mozarteum, we know the verified story of his death thanks to the extreme thinness of the bone capable of preserving the details of an accident (Puech, 2019). The decrease in bone thickness, a more prominent bulging skull with attenuation of the superciliary ridge are characteristics that appear at the end of the long process of evolution of anatomically modern man. This progressive juvenilization as an evolutionary phenomenon that foreshadows our future appearance is called neoteny.



Figure 21. The geometry of the features of Man shows a gracilisation of his skeleton during the evolution of time. The form becomes less massive and the size of the jaws and teeth are reduced with the succession of species during the march of humanity. Pithecanthropus IV and Mozart.

Yves Coppens was a paleoanthropologist colleague, however meetings about the use of teeth and the particularities of skulls cannot capture the full magnitude of the archaeological research of the prehistorian that have an historical aspect, embracing expeditions, collecting discoveries, and the development of palaeoanthropology who highlighted the work of specialists. A balance has been proposed between the story accompanied by the testimony of bones that punctuate our evolution over thousands of years and the way of thinking about prehistory to testify to a palaeontologist and excellent storyteller who invited us to discover humanity. The era, that of Yves Coppens, was marked by major international archaeological expeditions which made palaeoanthropology a specialty of the study of human evolution, which improved the understanding of our past. How dangerous is the evocation of encounters, writing them is a peril when the time has passed. You never know what makes the charm of a discipline that continues to evolve. No doubt on the instinct of Yves Coppens, as cultured as he is spontaneous, to let us know of the first attraction of a discovery.

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