Review Article

Dietary Heritages at the Dawn of Humankind in Sub-Saharan Africa

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Dietary heritage is a fundamental part of the history of humankind. Hominins' evolution has paralleled major shifts such as the introduction of lithic devises, gain mastery over fire, cooking, fermentation, plant and animal domestication, which, in turn, have been associated with anatomical, physiological, cognitive, sociocultural, and behavioural shifts. A holistic understanding may shed light not only on how human life evolved, but also on the mechanisms governing metabolism and prevalent metabolic syndromes in modern humankind. Food is essential for understanding human development, adaptation, environmental exploitation, cognition, technology, and survival, while adaptations to the habitat and lifestyle have led to changes in human genome from dietary transitions across hundreds of human generations. Ancient foods incorporate the complex milieu of phytonutrients in grains, native plants, mushrooms, fruits, legumes, nuts, honey, and seeds, being the nutritious building blocks of each heritage diet, essential for ensuring sustainable food security. What foods people ate in the past, how foods were prepared, and what does this disclose about daily lives, cultural values and social interactions, is a central data repository, and may give an indication of chronic disease prevention. The reconstruction of ancient diets is complex for many factors, including to the unpredictability of humans themselves. We address some cultural practices, dietary traditions, ancient diets and technological advancements in food preparation, and briefly the role of genetics and the gut microbiota.

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1. Introduction

Globally, current dietary patterns in most regions are neither healthy nor sustainable, being based on a complex system of food value chain which has several adverse effects on human health. Studying ancestral diets can help us understand how our eating habits have changed over time, honour our cultural traditions, how they may impact our health today, and how to develop present dietary strategies.

The "Cradle of Humankind", dating back more than 4 million years, is located in the Great Rift Valley located in East Africa, from the north-eastern part of the continent, Ethiopia, down to the southern region, South Africa. The world's richest and oldest hominin site was discovered some 50 km northwest of Johannesburg, South Africa, in the Gauteng province, where the first great ancestors of modern humans evolved and flourished.

The evolution of diet to present processed foods era is well documented, and our intention is to highlight some key points of ancestral diets, linking our ancestral diets to modern functional foods as a means of chronic disease prevention, deciphering the impact between patterns of human health and disease that defines contemporary diets.

The foods we enjoy and can digest today reflect ca. 6 million years of hominins biological and cultural evolution. The evolutionary history of hominins, based on cultural innovation and changes in habitat and ecology, including the progression of human dietary habits, depicts the development of humans themselves.

Significant breakthroughs in human history, such as the onset of stone tool equipment for hunting, collecting, processing, and eating foods, control of fire, the move to eat new types of foods as the meat-based diet, the headway in cooking methods and fermentation techniques, and the ca.12,000 years ago domestication of plants and animals, have significantly influenced human anatomical, physiological, social, cognitive, and behavioural changes[1].

Comprehending this evolution provides us with vital clues about the origin of life, and on the precise molecular mechanisms that operate in living beings and how they have changed in time, and therefore strengthen our aim in setting an agenda for further research on foods and dietary habits in SSA.

Many of the modern nutritional problems can be traced back to changes caused by the introduction of agriculture and, more recently, food technology, since in the last sixty years, there has been an alarming decline in food quality[2]. In contemporary SSA, the inheritance, innovation, and broadening the scope of applications of indigenous nutritional knowledge is very important trying to maintain nutrient-intense crops such as millets, conventional fruits, and vegetables, as barrier to highly processed foods, for the health and well-being of future generations[3].

Since the beginning humans interacted with Nature according to one ultimate vital essence, survival, above all on their capacity to secure the challenge of eating or being eaten, on the beloved short passage in time on Earth. To understand the biological character of humans and their distinct traits, the early developmental history must be examined, including on the major eating habits shifts in the human evolutionary framework[4].

A key issue in nutritional anthropology relates to the factors and outcomes of peoples' dietary preferences. Nevertheless achieving an accurate and explicit interpretation of what and how much mankind eat proves to be particularly challenging[5].

The archaeology of diet and nutrition, focused on the plant and animal remains that make up food, contributes effectively to our knowledge of the past behaviours, standards, and beliefs interconnected with food, and also with the present food systems[5][6].

Human foraging and subsistence strategies, foods, diets and nutrition are fundamental for perception of human behavioral patterns and livelihood schemes, for comparative social and evolutionary context, on the life of different communities present in a globally extensive range of environments[7][8][9].

In the Afar Gona River region, Ethiopia, it was discovered the oldest archaeological and geological evidence, dated 2.6 - 1.5 million years ago, through fossilized bones with evidence of stone tool cut marks[10]. Modern humans (*Homo sapiens*) originated in Africa[11] and adjustments to significant eating patterns changed during evolution, generating particular signatures in human genome[12].

The evolutionary history of hominins has been characterized by significant dietary mutations, and there were fundamental changes in body composition during early evolution. It is increasingly recognized that foods and beverages represent cultures and cuisines which are fundamental root basis on the identity of each society, integrating traditions and lifestyles, customs and values, rituals and beliefs, heritage, linking individuals with the food system[13][14].

The indispensable daily requirement of attaining and/or producing edible staples from the neighbouring settings, reveals indicators on the habitat itself, and also on the particular technological, economic, behavioural, and cultural characteristics of small groups and large populations alike[15].

Food and beverages are deeply ingrained in different cultures connecting nutrition and health, rituals, attitudes and conducts, regarding maintenance crops, agricultural production, manufacturing, and consumption, under subsistence systems or worldwide trade networks, with the related diffusion and dispersal of plants, animals, and man-made artefacts[16].

The earliest evidence of humans cooking a carbohydrate source is burnt tubers identified in the Cape coastline caves on the southern tip of South Africa, dating back some 120,000 years (**Figure 1**)[17]. By connecting toasted rhizomes and tubers as a staple with sources of protein and fats from fish, seafood, and animal wildlife, these communes were capable to exceptionally accommodate to their habitat, displaying high ecological awareness[18].

Figure 1. The Cape south coast of South Africa preserves a remarkably rich Middle Stone Age archaeological record, important to the origins of modern humans[19].

The Early Stone Age in Africa is roughly equivalent to what is called the Lower Palaeolithic in Europe and Asia, a time period lasting from about 2.6 million to between 400,000 and 250,000 years ago[20].

The data on remains of ancient cultures or eras comprise assorted artefacts as hunting bow and arrows, knives and cutlery, cookware and stockpots, pans, jugs, basins, as well as the residues of the plants and animals that were collected, hunted, grown, processed, and consumed as meals[21].

The importance of mainstreaming indigenous and local knowledge, passed down through generations, in global environmental policy and sustainable resources, has been firmly established since their territories coincide with some of the world's remaining major concentrations of the planet's biodiversity, while

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indigenous food systems often play a wider role in sustainable food systems to effectively confront climate change[22].

The SSA indigenous food systems, intimately tied to nature and spirituality, rather than to linear value chains[23], contain extensive and sophisticated knowledge of a vast mosaic of resources in agrobiodiversity, local foods and medicinal plants, and the ability to nurture biocultural knowledge, toughness against challenges, and rationally sustainable[24].

There is growing perception of the importance of modern interpretation of ancient dietary regimens and culinary cultural practices of people in a region, or historical period. The recreation of ancient diets is complex for many challenging factors, including to the unpredictability of humans themselves[25].

From this perspective, in SSA cultures a triad combination of "food, language and identity" reveals the centrality of food in the experience of being human in different geographical regions, while food choices are also influenced by local values, wealth, and social trends[26].

Food residues allow archaeologists to elaborate on extensive reconstructions of subsistence, analyse the complexities of the features of ancient economies based on agriculture and trade, social hierarchy stratification, veteran status, and different identities based on race, ethnicity, gender groupings, age, place of origin, religion, disability, sexual orientation, socioeconomic status, education, marital status, language, and ideologies[27].

Since ancient times, food has been a cornerstone of cultures, not just for survival, but also about family, community, and tradition, being a key feature of attraction in festivals and celebrations, where ritualistic and ethnic cuisine were served to family friends, sustainably proving that traditional native foods is also a cultural expression, that can be consumed in the simplest and most natural way[28].

Food delivery to Gods and deities is an ancient practice of humanity and the connection between food and religion dates back to old times as well as food taboos seen from virtually all human societies, e.g. eating meat and eggs is forbidden for pregnant women in one culture in Kenya[29]. The power of food is particularly important as communicative tool, through its direct linkage to culture and rituals, focusing on food practices, cultural memory and narrative performance, and as mediator in cultural gatherings.[30].

To implement a comprehensive rebuild of the former diets and lifestyle, it is necessary a multi-faceted method which can yield extensive, complex and flexible databanks to validate a rigorous study. Analyses of paleofaeces and coprolites provide good evidence but may be ambiguous, and biomolecular analysis of

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ancient molecules (especially nucleic acids, proteins, lipids, and carbohydrates) is necessary for correct interpretation[31].

Both genetic and fossil evidence place the origin of our species at about 200,000 years ago in Africa but there is much debate on the dietary adaptations of the robust SSA Lower Pleistocene *Paranthropus,* an ape-like hominin, a genus of extinct hominin, and hominin lineage.

It is of great interest in recognizing the fruitfulness of anthropological food studies for researching cultural processes since, in SSA, culture diversity is key in tackling the existing malnutrition and food insecurity, based on the experience, performance and narratives important to understand community configurations.

The main overarching theme addressed in this topic is to try and match human evolution with the progress of dietary heritage in radically different SSA regions, ranging from rainforests to deserts, our ancient ancestors rising in a variety of landscapes and locations, where first human remains of *Homo sapiens* evolved in East African savannas.

2. The Evolutionary Role of Diet in Sub-Saharan Africa

Human development has been affected by the gradual evolutionary dietary changes and although some innovative and all-embracing valuable experiences were reported, nevertheless, the isolation of ancient food matrices and their interactions remains analytically challenging[32].

Nutritional anthropology focuses primarily on the adaptive interactions of foods and diets with human biological systems, culture and environment, and is the interpretation of human subsistence lifestyles, in comparative social and evolutionary perspectives[9]. The nature and culture that define a SSA native smallholder food system, play a pivotal role acting in sustainability transformations stages, focused on development, addressing environmental, social, and governance, but are widely exposed and have received limited research[33].

“Food” is a term more than nutrition and has a culture defined identity, whose boundaries can be far-reaching or condensed to include or exclude beverages and some medicines. Food is essential for understanding human development, adaptation, environmental exploitation, cognition, technology, and survival, while adaptations to the habitat and lifestyle have led to changes in human genome from dietary transitions across hundreds of human generations[34][35].

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Nubia, a region along the Nile River, is considered Africa's oldest urban civilisation, where the traditional African diets were rich in starches from local foods such as cassava, tubes, fibre, fermented foods and beverages, wild plants, honey, plant proteins, local fish-hunting-gathering, and animal herding[36]. In SSA, diverse pre-historic camps have been found in southern Nubia in Sudan with cooking pottery dated 50,000 years ago and signals of sun-dried food processing rudimentary techniques[37][38].

The existence of tribal ethnic groups and boundaries in SSA, which are primarily social boundaries, also revealed that pastoralists were, as early as 7,500 BC, the first food producers to inhabit southern Egypt/northern Sudan in the Nabta basin, not for meat but for milk and blood consumption[39].

The selection of edibles by the earliest hominins, probably omnivorous, included large quantities of fruit, leaves, tubers, flowers, bark, insects and meat. The understanding of their diets have been of primary importance to our analysis of human evolution and vital for the comprehension of their paleoecology and our development[40].

Early Pleistocene hominins in southern and eastern Africa expanded their diets to include C4 photosynthetic characteristics plant resources which include maize, sorghum, pearl millet, sugarcane, millet, and grass (*Panicum maximum*)[41]. The study of Palaeolithic diet, with no cereals, milk and legumes, is perhaps the most critical component of research on past populations[42].

The fundamental, daily necessity of obtaining and/or producing food items from the surrounding environment provides clues about, not only the environment itself and its dynamic changes, but also the particular technological, economic, behavioural, and cultural characteristics of small groups and large populations alike[43].

In reality, investigations of dental archives (e.g. tooth size, shape, and structure) have been the benchmark for reconstructing diet of our ancestors and the biological life history, which is adequate due the importance of food in the origin, evolution, and behaviour of our species[44][45]. However, dental morphology and wear analyses indicate the predominant dietary proxies rather than its diversity[46].

From the beginnings of a settled agricultural way of life some 12,000 years ago, biological and cultural (dietary) changes have taken place modifying the way humans live, deviating from nomadic forager culture heritage to permanent habitation and farming[47].

The expanding of agriculture across SSA has long been attributed to the large-scale migration of some 400 distinct native ethnic groups speaking Bantu out of their west Central African homeland from about 4000 years ago[48]. Agriculture has no single, simple origin and its first traces involved profound

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transformations in human life history strategies and this transhumance impacted on several aspects of SSA demography and biology, including life-threatening situations, thriving population, adult body mass, and health status indicators[47][49].

Major dietary shifts in human evolution have undergone variations among regions and timeframes, especially in the significance of fishery products, and have raised questions of similarity in types of vestiges and difference in settlement pattern designs, between archaeological Palaeolithic humans and hominoid documented SSA foragers[50].

Over the last decades, SSA have become the core territory for researching the emergence of modern human behaviour[51]. Mozambique has been a region of study to assess the origins and dispersion of *Homo sapiens* within Africa, particularly in relation to Middle Stone Age (15,000 years) background and associated early modern integrative human cognitive ecology.[52][53].

Carbohydrate use, high in energy suppliers as sugars or starch, was observed on films of starch residues attached to stone tools, in Niassa woodlands in the Mozambican Rift, demonstrating the relevance of complex but soluble starch, among traditional groups, dating back more than 100,000 years ago. This discovery demonstrated the collection of wild grains (e.g. wild sorghum) pioneering showing that humans who lived there ate and processed grains into staples, when formerly was perceived as an irrelevant activity, and not as important as that of roots, fruits, berries, seeds, and nuts[54].

The Chicumbane site, one of the few Early Farming Community sites in the lower Limpopo Valley in Mozambique, an established itinerary main access between the inland and the coastline, indicates a diversity of cultures amidst systems and structural designs, and has been moderately investigated comprising a gap in the disclosure on the advent and evolution of farming communities[55][56].

The method of investigating organic residue comprises grinding up small pieces of pots fragments, and other materials (e.g. lithic tools), dug from archaeological sites and extracting preserved lipids preserved. Results from analysed pots, in Chicumbane site, dated the end of the first millennium AD, showed traces of vegetable oils present in the common local mafurra tree (*Trichilia emetica*)[57] and in the herb *Plectranthus,* which belongs to the sage family (Lamiaceae: e.g. lavender, basil, mint, oregano, thyme and rosemary), curiously with anti-malarial properties[58].

Five main habitats were found along the eastern coastline of SSA although in different proportions around each settlement: coral, estuary, sandy-muddy, mangrove, and open sea. Despite similar habitats along the Swahili coast, the consensus on the diet of early hominin species in deeply different habitats and cross-cultural frameworks remains elusive, making the practice of paleobiological reconstruction more challenging[59].

SSA is the birthplace of modern humans, but the benchmark and distribution of genetic variation over populations, and correlations with cultural and linguistic diversity, have been understudied, not allowing the reconstruction of the archaeological and genetic data that could explain the demographic history of the Continent[60].

Human genome experienced over the past 50,000 years a number of selective evolutionary forces, but since the origin of *Homo sapiens*, most of the pathways of communication nutrients-genes have not changed, while there is a misalignment of modern diets and the genome formed through time and human genes cannot keep up with adaptation to modern diet[61][62].

3. Cultural Practices and Dietary Traditions

3.1. Meat-eating

The first major evolutionary change in the human diet was the incorporation of meat and marrow from large animals, which occurred by at least 2.6 million years ago. Meat is unlikely to have been part of the diet in consistent amounts throughout the year over our evolutionary history, with plants making up a much more important contribution during the wet seasons[63].

Anthropologists infer ancient diets from indirect evidence such as dental microwear and jaw and tooth shape, while 1.8-million-year-old hominids found in SSA, thought to have eaten meat, had much smaller teeth and chewing muscles.

By at least 2.5 million years ago, a remarkable expansion in diet type started to occur as some hominins began incorporating meat and marrow from small to very large animals into their diet, demonstrated by butchery marks found on bones[64][65].

Most nonhuman primates prey on vertebrates, but primates like chimpanzees do not eat meat normally. Meat is a relatively marginal dietary component of chimpanzees seen in tropical hunter-gatherer societies, and the over-reliance on higher-quality protein resources rich in essential amino acids, may have driven improved neurogenesis on brain tissues and physiological development[66].

There are multiple interpretations of the modern Palaeolithic diet, presumed to be established on a fragmentary or replicated version the human diet during this “Old Stone Age” i.e. roughly 2.5 million years

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ago to 10,000 B.C., with the onset of agriculture.[42].

Regardless the many critical scientific issues to recreate past dietary profiles from bones and teeth examination, only through recent interdisciplinary partnership is now possible to infer the general nutritional status of past peasants and groups of SSA[67].

Cannibalism in humans has been observed for at least 1.45 million years ago but not evident if out of necessity or driven by social reasons as part of their ancient culture, but demonstrating the consumption of human meat, organs and bone marrow[68].

All these deviations contribute a non-compliance to the consumption of grains, such as rice, barley, wheat, maize, quinoa, buckwheat, oats, teff, millet, amaranth, sorghum, rye and triticale, whole grains both higher in nutrients and dietary fibre, as compared to refined grain alternatives[25].

Human dietary shifts across generations to include meat, supplying high quality protein, vitamins B (B12; B3), creatine, taurine, choline, zinc, heme iron, and tryptophan, played a crucial role in allowing humans to evolve and thrive, reflected in an increase in body and brain size, humans being competent hunters and not mere scavengers[69].

This is justified by the physiological human requirements for protein of better quality in relation to essential amino acids (e.g. lysine) since complete animal proteins supply them more effectively than incomplete plant proteins, lacking one or more of the nine types of essential amino acids. Foods based on animal products and by-products, in contrast to plant foods, are regarded to have higher protein to energy ratios and better digestibility of crude protein and amino acids[70].

Meat makes up a fragment (<10%) of overall food mass and energy, delivering most of the global vitamin B12 intake, performing a leading function in the supply of vitamin A and other B vitamins, essential long-chain Ω-3 fatty acids, several minerals in bioavailable forms (e.g., iron and zinc), and a variety of bioactive compounds with health-improving potential.[71]

The dietary specialisations in the Mio-Pliocene of all the large terrestrial meat-eating, evaluated through mandibular dentition, showed that they had less sharp premolars than do their modern confamiliars, an indication of greater durophagy, the feeding habit of consuming exoskeleton-bearing organisms, such as bivalves, gastropods, and large crustaceans, indicating prominent obligate carnivores[72][73].

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3.2. Aquatic Food Resources of Ancient Communities

Ancient communities employing a variety of strategies, developed, exploited, and consumed marine foods while unexpectedly aquaculture initiated some 8000 years ago in China, with archaeologists now referencing aquafarming systems across the globe, even SSA, long-lasting, even for millennia[74]. In Egypt and Eritrea, burial chamber paintings and low-reliefs portraying men fishing in constructed puddles, illustrate the effective farming of fish as early as 2500 BC[75][76].

All organisms encounter some amount of environmental change. The link between climate and hominin evolution is entrenched on the notion that assets and ability crucial for the subsistence of hominins, did determine the critical placement of hominin settings in planned patterns with easy access to namely water and particular types of vegetation[77].

Through ichthyoarchaeological analysis it was possible to redesign both social context and habitat aspects of life on the Swahili coast, with diverse African cultures, made up of a confluence of peoples[78]. Modern humans evolved on a long, interconnected and reliance history with oceans, rivers, lakes, coral reefs, coastal and marine ecosystems and different aquatic species, as revealed by archaeo-historical analysis which offer longer chronological outlook than more recent ecological research[79][80].

Fish and seafood indigenous peoples' procurement, consumption, and discard practices, and subsistence strategies, have long been important areas of archaeological research as they represent the interface of a society's social organization, economic system, equipment, with Nature, the environment, biomass availability, early modern globalization, , and explain human-environmental relations[81].

The evolutionary context of the introduction of aquatic foods to the hominin diet, showed that along coastal areas communities depended massively on systematic and committed exploitation of marine foods revealed by accumulated immense sediment on many bivalve shell refusal heaps, through fierce gathering of predominantly black mussels (e.g. *Choromytilus meridionalis*)[51].

In the Swahili coast of East Africa, early Iron Age sites contain substantial evidence for the exploitation of aquatic resources, including fish bones and shellfish, also describing the canoes and fish traps[82]. It is commonly endorsed that aquaculture uprose multiple times in societies as an evolution from capturing and trapping fish, but aquaculture is nothing new. It has a long, fascinating history that stretches from antiquity at least 8,000 years ago[83].

The exploitation of oceanic and pelagic fish, which coincides with the more frequent consumption of domesticated bovines more than 10,000 years ago, and the ways in which human communities made use of them, sustains the evidence that fisheries and aquaculture currently provide a great fraction (20-25%) of the most important protein systems[84][85].

One of the most exceptional adaptations to extreme drought is found in lungfish that are survivors of a very ancient group of fish which were once worldwide, placed in subclass *Choanichthyes*, genus *Protopterus* (**Figure 2**). They live in the swamps and muddy rivers of SSA, where they dwell in deep dry mud up for weeks or months inside a cocoon of slime and can remain inactive[86]. They have survived unchanged for so long (nearly 400 million years) that they are sometimes nicknamed “living fossils” as they survive dry periods in a hibernation stage[87].

Figure 2. Mudfish or lungfish, food source of inland ancient people in SSA, can reach 2 meters long and survive in a dormancy period.

3.3. Consumption of Edible Insects (Entomophagy)

Everywhere in the world people ate various insects, especially common in the tropics, and this developed into traditional entomophagy. Eating some 2,000 different insects depend on region and culture, and is justified by the nutritional benefits of insects, their profusion (e.g. plagues) and easy to obtain, and the cultural, ritual, and a range of roles insects play with religious significance of certain species[88][89].

Edible insects were and are popularly consumed in SSA, and they and they serve a key socio-economic function for rural communities in Africa, by providing natural nourishing food and income opportunities to dealers and farmers[90].

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There is also a long historical connection between insects and human culture. The large edible caterpillar *Gonimbrasia belina* is a species of moth which is native to the warmer parts of SSA (e.g. Mozambique, Botswana, Namibia, South Africa, Zimbabwe), that feeds in mopane (*Colophospermum mopane*) and mango tree leaves, and are important source of low-cost, low-maintenance, high protein for natives in the region[91].

Traditionally, mopane worms (the most important insect in SSA from a cultural point of view), were harvested for subsistence, but since the 50's this edible worm represent an important sector in the local rural economy, being commercially produced on a multi-million trade in edible insects on a specific season[92].

There is no documented history of when Mopani worms became a part of SSA diet, but 6,000-year-old dried Mopani worms have been found in stone-age pits in Pomongwe Cave in Zimbabwe[93][94].

In southern Ghana, palm weevil larvae (*Rynchophorus phoenicis*) are one of the most widely consumed insects considered a delicacy[95]. (**Figure 3**).

Figure 3. Edible matumane caterpillar *Gonimbrasia belina* (left). Palm weevil larvae (*Rynchophorus phoenicis*) (right), common in Mozambique.

Bees are winged insects and ancient Egyptian honey dated around 2,400 BC and alcohols, among others, with its non-perishable properties, have been one of the oldest found edible foods[96].

3.4. Human Evolution and Need for Drinking Water

To sustain life, humans must maintain a tight balance of water gain and water loss each day. Throughout history people have drastically engineered their environments to ensure access to water, and it turns out that much as food has shaped human evolution, so, too, has water.

Early human settlements developed by creating very strong dependent links with in situ water, and they have thrived around available and sustainable water resources, crucial for human life, while access to freshwater has historically determined where civilizations began and developed[97][98].

The success of finding drinking water on a daily basis, to regulate heat equilibrium and prevent dehydration, played a substantial role in shaping hominin evolution[99]. The ratio surface area to body mass is a prominent impact on energy exchange, exposure to solar radiation and other factors, affecting water requirements, while adaptation to climate change and the thermoregulatory selection pressures were probably major leverages on hominid evolution[100][101].

For thousands or even millions of years, crossing of a water barrier (e.g. rivers, sea straits), hominins expanded throughout the world on several migration routes[102]. Ecosystems vary in the amount of water they hold, and high water-holding forests are essential for adapting to drought climates under global warming, and a central issue is which type of forests could conserve more water in the ecosystem[101].

Early *Homo sapiens* lived in SSA river valleys with extensive, rich arable lands filled with savannah, alluvial plains, forests, mangroves, and marshlands that abounded with hippos, a great diversity of grazing animals (e.g. zebras, antelopes), and many other animals, some extinct for millennia (e.g. giant Cape Buffalo - *Syncerus antiquus*)[103].

3.5. The Narrative of Earth-eating

The deliberate driven practice of consumption of soil/clay (geophagy) has been going on for millennia until now, and cuts across socio-economic, ethnic, religious and racial divides, but this ancient cultural practice has not been thoroughly studied for eventual detrimental health issues and risks[104][105][106][107][108].

Geophagia, a form of pica, among members of the animal kingdom, including humans, is defined as an eating disorder, with deliberate consumption of earth, sand, soil, anthill, termite agglomerates, or clay, and has long been reported from Roman physicians to 18th century explorers[109][110].

It has been regarded as a mental disorder, archaeological, biological, cultural, linguistic, religious, symbolic and other phenomenon, culturally authorized tradition or an outcome to poverty and famine[110][111].

The original testimony of geophagy experienced by humans dates from the 300,000 BC prehistoric site at Kalambo Falls on the border between Zambia and Tanzania[112]. Here, a calcium-rich white clay was found alongside the bones of *Homo habilis* (the immediate predecessor of *Homo sapiens*)[108].

Earth material intake has been reported in India and South America, and in Africa namely in Zambia, Zimbabwe, Ghana, Malawi, Chad, Swaziland, Togo, Nigeria, Mozambique, and South Africa, mainly in pregnant women and young people[113][114]. (**Figure 4**).

Figure 4. A common termite hill. A woman in Mozambique eating termite hill handmade clay balls, a better shaping material than ordinary argil, usually sold in contemporary small SSA markets, often flavoured with spices such as black pepper and cardamom.

Termite clay has a unique variety of soil enzymes (e.g. protease, dehydrogenase, urease, and phosphatase) indicators of soil microbiome, but no research has been conducted designed to target the improvement of specific enzymes to alleviate the deficiency of a particular soil nutrient[115].

The clinical outcomes of geophagy are thought to include both beneficial and deleterious effects, while the safety of people consuming earth is still poorly understood mainly in SSA and its aetiology remains obscure[116]. Toxic effects have been studied but metabolic studies are still necessary since it has been well documented the human requirement for silica[117] and the eventual beneficial biological role of germanium[118] and probiotics[119][120][121].

The aetiology of geophagy remains elusive, controversial and inconclusive. The period on intake is normally sporadic (e.g. pregnancy; menstrual spells) due to the presence of essential minerals in the geophagic soils which may however be accompanied by toxic heavy metals in some cases predicted to have carcinogenic effects[122].

Another type of geophagy involves food-grade diatomaceous earth, a type sand in powder made from the sediment of fossilized microscopic algae capable of photosynthesis (diatoms), with more than 150,000 varieties, found in streams, rivers, lakes, and oceans around the world, and mined from dry beds of these waters. Its use dates back to ancient civilizations, mainly in Egypt[123], and presently used as adsorbents for alleviating toxic effects of mycotoxins[124].

The evolution of algae, zooplankton, and sponges has removed silica from the oceans, and the cells of these tiny algae are high in silica (80-90%), the dried sediment produced from these fossils supply high levels of silica and trace amounts of sodium, magnesium, iron, and germanium. But there is little scientific evidence of any nutritional or health benefits[125].

In SSA, near termite hills, a mushroom with some 52 species of *Termitomyces* blossoms, whose cap may reach 1 metre in diameter, and is a nutrient rich provider for natives and probably for ancient hominis. (**Figure 5**).

Figure 5. Mushroom *Termytomices,* known to have a cap that can reach 1 meter diameter, on road sale in northern Mozambique.

4. Ancient Diets and Technological Advancements in Food Preparation

Today, most humans are omnivores and at some point our ancestors learned to cook with fire, which softened food for easier chewing, digestion, better taste, and unknowingly killing parasites.

Dietary shifts from the past may even have led to the evolutionary change in the human skull normal phenotypic variation in craniofacial configuration and larger brains, requiring the consistent consumption of highly nutritious foods, while prompting a smaller digestive tract[126][127].

Humans started using hand-held stone tools to process meat over 3 million years ago, rudimentary but crucial technology crucial. The development of stone tools to cut, pound and crush, allowed early humans to hunt, process, and consume meat more efficiently. Spoons from Ancient Egypt date back to 1,000 BC made from wood, bone, horn, ivory, flint, and stone, and were the first eating tool, while the use of knives on tables coincides with the early 1300s.

The technology of early metallurgy and the art of forgery began about 4,000 BC with the Bronze Age. The control of fire, irrigation and land cultivation, were even more significant technological advancements, enabling cooking, which not only made food more palatable but also easier to digest and safer from pathogens[128].

Parasites are important food-borne pathogens. Most common parasites presently include *Cryptosporidium* spp., *Toxoplasma gondii* and *Echinococcus* spp., and while today cooking/freezing any meat/fish to proper temperature will kill parasites, human ancestors were commonly parasitized by mainly three different species of tapeworms: *Taenia solium*, *Taenia saginata*, and *Taenia asiatica*, probably acquiring these parasites after consuming of antelope meat infected with lion or hyena tapeworm cysts[129].

Presently, the global dietary change and unstable food security and prevalence of food insecurity in SSA, it is important to understand food and nutrition in evolutionary, ecological, and social contexts, in order to try and reverse the significant food insecurity challenges, mainly caused by food imports[130][131] (**Figure 6**).

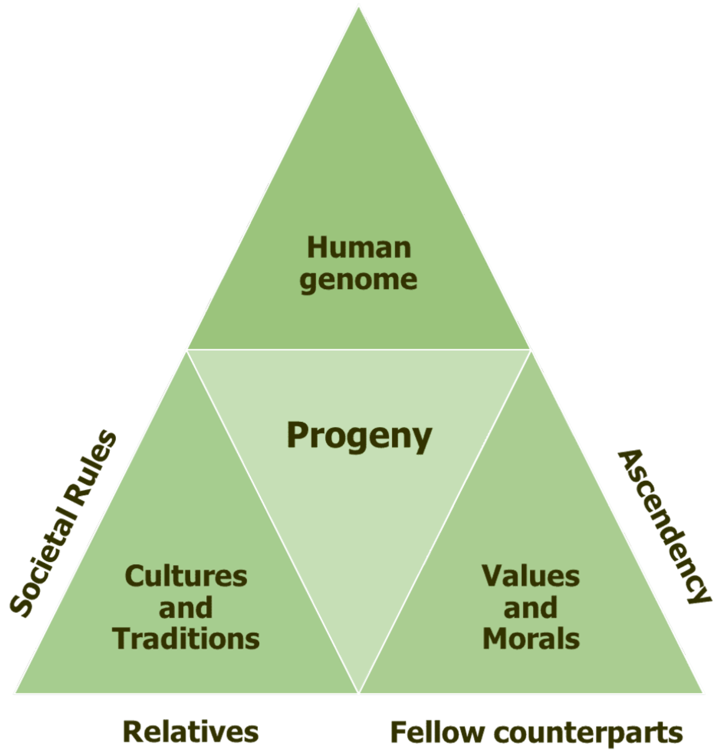

Figure 6. Biological and cultural evolution are not separate. Generations are affected not only by genetic code but also by phenotypic influences such as environment, foods, and specific cultures.

Grains, seaweeds, diatomaceous, kelp, mushrooms, moss, mice, rats, reptiles and insects were widely consumed, before the introduction of fish and meat from domesticated animals. Nowadays, the problems with grains, as more and more people become allergic to wheat and gluten, may justify studies on the original "Palaeolithic diet" on the geographical region in question[132].

A classic example of gene-culture coevolution is lactase persistence in human adults, less often in SSA individuals. Furthermore, recent evidence suggests that the timing of introduction, types, and amounts of complementary foods/allergenic foods may influence the risk of subsequent allergic disease[133].

State-of-the-art life science technologies help generate a new appreciation of forager's hunter-gatherer nourishment (e.g. butchered bones, discarded fruit stones and cracked nut shells) and indicate the dietary sophistication that pre-dates the first farmers, with the latest "bioarchaeology" revealing a prehistoric menu more varied and sophisticated than anyone expected[134].

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5. Evolutionary Genetics and Microbiota Adaptations

Ancient history is getting a rewrite through ancient DNA research where new information is revealed on the genetic relationship between modern humans and ancient human species, demonstrating that Neanderthals' genome is more similar to present-day humans in Eurasia (Europe and Asia) than to present-day humans in SSA[135].

DNA genomic study from detached dental tartar supplied data about dietary elements consumed, type of domesticated plants and animals, genetic variants for dietary adaptation that could have important health consequences in current society, but failed to supply detailed facts about specific foods ingested[136].

Non adaptive trait of the lagging during anaphase genome to repeated nutritional transitions, causes a genomic instability, now recognized as a hallmark event, which may reinforce a wide range of commonly named civilization diseases, such as acne, diabetes, obesity, cardiovascular diseases, neurodegenerative disorders, and cancers[137].

A new series of different and effective methods and approaches are required to understand the relationships and interactions that people have with food[138]. Over the previous decade, there has been a combined cooperation to upgrade the efficiency of the techniques of DNA recovery from precious archaeological specimens, such as the essential elements as human bones and teeth[139].

Through advancements in ancient DNA research, and despite high degree of damage, it will be possible to achieve a significant challenge in the generation of genome-wide sequence data from ancient skeletal and food remains, expanding our understanding of evolution and migration[140].

The gut microbiota population diversity increases in the time between childhood and adulthood and decreases at older age, rapidly developing from birth until 2 to 3 years of age, when adult-like composition and stability is established. Presently, the relationship between infant feeding practices and the microbiome, as well as its implications on allergies and food intolerances in infants has been studied[141].

The prevalence of diet-related selection events, selected food components, and more recent research on gut microbiome interlink with these elements and the human host, provided multiple candidates awaiting further investigation[142].

The importance of studying ancestral human gut microbiome, proven to be associated with chronic diseases, is important since relatively little is known about the composition of pre-industrial gut

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microbiomes[143]. These findings would facilitate the revelation and description of previously undisclosed gut microbiota from ancient microbiomes through genome reconstruction from paleofaeces[144].

Research into the African human gut microbiota is increasing fast, focused on the influence of overall lifestyle and dietary factors on gut microbiota ecosystem, its evolution during infancy, and the interrelationships between the microbiome, infectious disease, and undernutrition[145][146][147][148].

Dispersal of microorganisms can now be addressed by archaeogenetic techniques, using stable isotope and ancient DNA data, while the next-generation sequencing prompted a reversal in genomics research, offering exceptional proficiency for analysing DNA and RNA molecules in a high-yielding and profitable manner[149][150].

Metagenomic data may be analysed to check if transitions also impacted the microbiome composition, thus providing important insights into living conditions and health in the past[151]. .

Evidence from plant food compost to biological waste residue analysis, decoding fractions of some lipid biomarkers, the latest type of bioarchaeology through stable isotope analysis, reveals a prehistoric menu more varied and sophisticated than anyone expected, but, notably, a strong preference for plants[152].

6. Concluding Remarks

The history of dietary habits is the narrative of humankind. Presently, we can only provide few glimpses of how SSA people and first farmers have been evolving for millennia. Regrettably, the reconstruction of prehistoric diets is no easy matter. While food and nutrition determine many aspects of humanity development, it is unlikely that the scraps discarded from meals can give an accurate impression of what was actually on the prehistoric grub.

The types of foodstuffs within SSA habitat groups varied among settlements, depending on a combination of their particular cultural and environmental backgrounds along the coast and inner lands. This heterogeneity emphasizes the concerns and challenges in characterizing what constitutes an “optimal” diet for all humans, still an emerging area. Indeed, it appears that there is no optimal diet, although there are global dietary guidelines probably not fit for purpose in SSA, which minimize a host of diet-mediated illnesses.

More is unknown about food and health than is known. Future studies that integrate isotopic and biomarker analyses of food residues as indicators of diets for health research will enhance archaeological interpretations of SSA pottery use and culinary practices by offering precise chemical signatures of specific ingredients and molecules.

We hope this article serves as a significant step toward advancing the teaching of terrestrial and underwater archaeology, as well as general anthropology, in SSA universities. Also, to promote community engagement, heritage protection, public education, and potentially signal a paradigmatic shift in archaeo-nutritional research.

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Consent to Participate

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