



The Mobility Hypothesis: Evolutionary Perspectives

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Abstract

As can be seen from its multiple synonyms, adjustability, versatility, flexibility, adaptability, etc., mobility is one of the core engines of human biological and cultural evolution. It all started with bipedal gait, manifested itself transfer of raw material through space, generated mobility technologies with far reaching consequences that will very likely result in a new speciation event if humans colonize another planet. This brief presentation outlines the long-term evolutionary implications of mobility through the formulation of a simple parsimonious model articulated on three facets of the evolutionary process:

- Speciation event
- Adaptive radiation
- Founder effect

The model dubbed "SARFE" and applied to hominins in this paper, is testable and applicable to virtually all aspects of human biological and cultural evolution.

Keywords: Mobility; Speciation; Adaptive Radiation; Founder Effect; Ardipithecines; Australopithecines; Homo Sp.; Out of Africa

Introduction: The Mobility Hypothesis

Two series of totally independent events inspired the hypothesis formulated in this paper that "mobility is the overarching process driving human long-term biological and cultural evolution". The first series of events consists of the tragedies of migrants' crises triggered by combinations of different processes ranging from extreme poverty to political violence, one of the dominant aspects of the beginning of this 21st century. People from Western Asia and Africa try to reach Europe and Australia. Those from South and Central America move north trying to access the United States of America. It is however not the moral or ethical dimension – important indeed – of these crises that is addressed in this

short contribution but its long-term evolutionary implication as will be shown later.

The second set is the lock-downs imposed in different parts of the world to fight against the Covid-19 pandemic, implementing a ban on mobility, provisionally for public health reasons. Paradoxically, these dramatic moves bring to the fore the foundational nature of mobility for human beings. It may have started with the series of mutations that, through natural selection, led to the adoption of bipedal gait by a few groups of hominins some 7-6 Ma ago. Hominids and later human population movements became a constant of Human History, a constitutive aspect of its very existence.

Multi-Scalar Mobility

Humans with their commensals expanded in virtually all the world's ecosystems, from the tropical to the periglacial zones. This expansion operated at different space-time scales. It started some 3-2.5 million years ago, with pulls and pushes followed by relatively long adaptive stasis and keeps going on today. Much of the initial human expansion took place within the context of hunting-gathering lifeways, with two kinds of mobility dominant in prehistory: routine subsistence mobility on the one hand and push forward territorial expansion on the other. Agro-ecological systems generated their own mobility patterns with settlement relocation following fallow systems. Urbanization and contemporary societies are sustained by constant transfer of people, information, and goods via mobility technologies.

For 99.99% of their relatively short evolutionary history, human communities were entirely mobile. Mobility was, and still is multi-scalar, embedded in subsistence as well as global social systems. It ranges from the rounds of daily-life activities to planned and un-planned changes of localities, as well as exploration and settlement in new places. Human long-term history can be read from the perspective of mobility and its derived technologies.

For a very long time, with only human locomotion and muscular energy as exclusive mobility engines, transportability was a critical bottleneck in human history [1]. Carrying raw material, collected resources, and infants required the invention of different devices and containers, all initially made of perishable materials. The manufacture of early high-sea watercrafts is indirectly indicated by Modern humans' settlement in Sahul (North Australia) some 65,000 years ago. An exploit that required a 90-100 kilometers sea-crossing from the Wallacea to North Sahul. Objects geared to water bodies crossing, at different spatial scales, came to be the first significant artefacts of human engineering. Direct and indirect evidence of high sea navigation are indicated by the circulation obsidian from Melos Island, the presence of tuna fish bones -suggesting high sea fishing- and domesticated sheep/goats in the Eastern Mediterranean Sea islands. Early Holocene dug-outs are found further inland, as is the case for the 8000 years BP Dufuna specimen in Northeastern Nigeria [2] and the 6000 years BP one on the ancient shore of the Seine river in Paris-Bercy, France [3]. With the domestication of plants and animals, animal power was progressively harnessed in different parts of the world from the Middle Holocene onwards. Within a process summed up under the concept of "Secondary Product Revolution", cattle, horses, donkeys, camels, dromedaries and Lamas opened the era of animal-based transportation systems. The invention of the wheel in 3500 BCE in Mesopotamia, coupled with animal power assisted in the construction of the earliest transport

and agricultural machines. The European industrial revolution led to the invention of the steamboat in 1812, the steam-train in 1825, and the car -automobile- internal combustion engine in 1886. All these inventions facilitated and amplified goods and human mobility. Today, mobility machines move people in the air, on land, on and under water, with interplanetary travels very likely in the future. The implication of this long-term perspective is fundamentally that every human, every community, every nation, is the product of deep time multi-scalar mobility.

Evolutionary Perspectives

In a paper entitled "Punctuated equilibria: An alternative to phyletic gradualism" published in 1972, Eldredge N, et al. [4] mounted a frontal challenge to Darwinian gradualism. They argued that evolutionary development is made of limited episodes of rapid speciation [punctuations] between long periods of stability [equilibrium], also known as "stasis". The derived theoretical development, the "extended evolutionary synthesis" [EES], is particularly suitable and effective for the evolutionary modelling that will be formulated below. Biological evolution operates through random mutations and natural selection. These two totally independent processes are "blind", have no goals, and result in either extinctions or emergence of new species. The evolutionary scenario can be spelled out in a series of successive steps: 1-speciation event; 2-adaptive radiation; and 3-founder effect. The invention of tools and the ensuing cultural transmission added to the biological dynamics that is always in operation.

Speciation

"Speciation" is a biological lineage-splitting event that result in the emergence of two or more separate species. "Divergent selection may generate barriers to gene flow and ultimately lead to the evolution of distinct species-a process referred to as ecological speciation. Partial reproductive isolation can arise as a by-product of local adaptation within dozens to a few hundred generations, suggesting that divergent selection may initiate speciation over ecological timescales; more uncertain, however, is how often and at what pace divergence proceeds along the speciation continuum until strong reproductive isolation is established" [5].

Adaptive Radiation

Adaptive radiation refers to the process through which a lineage diversifies rapidly with the newly formed species following different adaptations, each a response to an opportunity. It is characterized by great ecological and morphological diversity, the driving force behind it being the adaptation of organisms to new ecological contexts [6,7]. Expansion in new territories without competitors, such as

new environmental settings and/or islands, offers optimal condition for adaptive radiations.

Founder Effect

Founder effect is a special case of genetic drift. The latter is an evolution mechanism in which allele frequencies of a given population change randomly over generations. The former applies to a small group that split from the main population and established a colony. Having separated from its initial larger population, the new group may contain different allele frequencies and as such represent narrower genetic diversity. Founder speciation has been suggested to be a potent force in the generation of new species. However, “the relative frequency of changes in the genetic and the phenotypic composition of a population due to founder effects, and the importance of these changes, remain a contentious issue on the nature of the evolutionary process [8].

As demonstrated in the above discussion, mobility at different pace and scale is a core dimension of evolutionary change and construction of Humanity. The evolutionary model outlined above, labeled SARFE – [S for Speciation, AR for Adaptive Radiation, and FE for Founder Effect] is applicable to virtually all aspects of human biological and social evolution. Miocene hominids, Gigantopithecus, Sivapithecus, and Dryopithecus branched off and cannot be considered as remote human ancestors. The current human phylogenetic tree thus started with SARFE 1, ranging from 7 to 4.5 Ma in Africa with the Ardipithecines: *Sahelanthropus tchadensis* (7 Ma) in Chad Republic, north central Africa, *Orrorin tugenensis* (6 Ma) in Kenya, East Africa), *Ardipithecus kadabba* (5.8-5.2 Ma) and *Ar. ramidus* (4.4 Ma) in Ethiopia, with a territorial range limited to Chad-Ethiopia-Kenya.

SARFE 2 consists of two branches, one with gracile and the other with robust forms, known as *Paranthropus*. The gracile australopithecines with *Au. anamensis* (4.2-3.8 Ma), *Au. afarensis* (3.9-2.9 Ma), *Au. africanus* (3.6-2 Ma), *Au. garhi* (2.6-2.5 Ma), *Au. bahrelghazali* (3.5 Ma), and *Au. sediba* (1.9-1.7 Ma), range from 4.2 to 1.7 Ma, spread over a more extensive territory from North central Africa to the southern tip of the continent. The *Paranthropus* branch limited to eastern and southern Africa includes *P. aethiopicus* (2.7-2.3 Ma), *P. bosei* (2.3-1.34 Ma), and *P. robustus* (2-0.6 Ma). The production of human made objects started in SARFE 2.

Without going further in details because of limited space, SARFE 3 [also known as Out of Africa 1] includes all early Homo species with stone knapping technology who spread all over the Old-World middle latitudes, reaching western and eastern Eurasia and well as Island Southeast Asia from 2.5 to 3/200,000 years ago. SARFE 4 [Out of Africa 2], the

“human cognitive revolution”, witnessed the expansion of modern humans all over the planet during the last 300,000 years, resulting in the extinction of 3 and partial absorption of 2 of 5 other species. SARFE 5 will very likely take place via interplanetary travels if there is successful colonization of another planet. Contemporary Human genetic make-up and languages [9-12] feature the same evolutionary dynamics. It can even be said that, provided necessary adjustments, SARFE theoretical approach can help understand the evolution of many other aspects of human cultural developments, ancient and contemporaneous. Human mobility cannot be stopped. It is the engine of human biology and cultural creativity.

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