Materials for a Natural History of Human Populations

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Translated by
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*“*All philosophers suffer from the same defect, in that they start with present day man and think they can arrive at their goal by analyzing him. Instinctively they let "man" hover before them as an *aeterna veritas*, something unchanging in all turmoil, a secure measure of things. But everything the philosopher asserts about man is basically no more than a statement about man within a *very limited* time span. A lack of historical sense is the congenital defect of all philosophers. Some unwittingly even take the most recent form of man, as it developed under the imprint of certain religions or even certain political events, as the fixed form from which one must proceed. They will not understand that man has evolved, that the faculty of knowledge has also evolved, while some of them even permit themselves to spin the whole world from out of this faculty of knowledge. Now, everything *essential* in human development occurred in primeval times, long before those four thousand years with which we are more or less familiar. Man probably hasn't changed much more in these years. But the philosopher sees "instincts" in present-day man, and assumes that they belong to the unchangeable facts of human nature, that they can, to that extent, provide a key to the understanding of the world in general. This entire teleology is predicated on the ability to speak about man of the last four thousand years as if he were eternal, the natural direction of all things in the world from the beginning. But everything has evolved; there are *no eternal facts*, nor are there any absolute truths. Thus *historical philosophizing* is necessary henceforth, and the virtue of modesty as well.*”*

Friedrich Nietzsche (1878)

INDEX

PREFACE

Between the late 1990s and the early 2000s, while I was still pursuing my degree in Natural Sciences at University of Palermo, my interest focused on the evolution of our species, and in particular on its social evolution. After my initial readings in paleoanthropology and cultural anthropology, I decided to undertake a study on the social evolution of human populations, drawing mainly on my naturalistic background. This led me to begin a period of more in-depth bibliographic research and, at the same time, to develop ideas that eventually resulted in the writing of an experimental thesis titled: *Riflessioni sul processo di espansione di Homo sapiens e sulla sua evoluzione ecologica e sociale durante la transizione pleistocene-olocene (A.A. 2002-2003)* [*Reflections on the expansion process of Homo sapiens and on its ecological and social evolution during the pleistocene-holocene transition (Academic Year 2002-2003)]*.

The present work is a shorter and partially revised version of that thesis. It's a study on the evolution of our species that employs concepts and methods from Biogeography and Ecology which, though seemingly distant from anthropological discourse, have in my opinion been ignored or underestimated by anthropologists for far too long - and not only by them.

It is well known that, at least until a few decades ago, naturalistic studies and traditional approaches in the human sciences and cultural anthropology followed separate paths, especially in Italy, where ideas (and "truths") about the nature of our species have been almost exclusively the domain of humanists and theologians.

Today, it is clear that we cannot separate the biological nature of *Homo sapiens* from its cultural nature. Nor can we, for obvious ontological reasons, hope to properly interpret the human animal without first acquiring the theoretical foundations needed to understand the evolutionary dynamics - in space and time - of species, and of the natural world in general, of which *Homo sapiens* is a part and with which it interacts.

I am convinced that Anthropology - understood as the study of the natural history of human populations - when it interacts with other naturalistic and humanistic disciplines, can pave the way for an interpretation of human nature that is more "scientific" (that is, more intellectually honest) and as little "ideological" as possible. Anthropology can and must fulfill this role,

and finally establish itself not merely as one of many interpretive alternatives, but as the essential and indispensable starting point for understanding human nature - something which, in my opinion, would have numerous positive repercussions on our social life.

From this conviction - perhaps a somewhat romantic one - arose the motivation and the interest to continue my study over the years.

I could never have written this work without the help of Professor Mario Zunino, biogeographer and heretical thinker who profoundly influenced my training as a naturalist; of Professor Luca Sineo, who gave me great support in my bibliographic research; and without the help of my family, who supported me financially and in many other ways. A heartfelt thanks also goes to Laura, my partner, for her moral support and patience.

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1. INTRODUCTION

This paper follows a study of the biogeographical, ecological and cultural history of the *Homo sapiens* populations since their origin, currently believed to have occurred in Africa at least at the beginning of the Late Pleistocene, or even during the final Middle Pleistocene (200,000-100,000 years ago), until the early Holocene (around 10,000 years ago).

From a theoretical standpoint, and following an historical-naturalistic methodological approach, the aim of this research is to reconstruct and interpret the general characteristics of the first *Homo sapiens* populations and their socio-ecological evolution.

Therefore, this work specifically focuses on the issue of the origins of agriculture, and on the research of the main historical, contingent and necessity factors that independently and in different times directed human populations, that were distributed in specific regions of the planet, towards the adoption of an alternative productive strategy to hunting and gathering.

The objects of this study are the *human population units*, an expression indicating evolutionary realities with some internal cohesion that, thanks to their geographical, reproductive and linguistic-cultural isolation, interact with the environment and with other *human population units* in a relatively unified way.

The *human population units* do not just represent a group of individuals that is distributed in a geographical area, they first of all are social systems.

Therefore, each unit does not only evolve along a simultaneously spatial and ecological directrix, following the modalities of all living beings, but being a social system it also evolves as an adaptative complex system. Social systems, like all natural complex systems, can be characterized by a cycle (*cyclical evolution*) where the *growth-equilibrium-dissolution-reorganization* phases alternate (Marten, 2001).

Spatially, a dispersion phase, a stability phase, a contraction phase and a fragmentation phase (also after an active dispersion event) of the human population unit's distribution area could respectively correspond to each of the four phases that a social system goes through. Specifically, it is worthy to underline that it is the presence of a species (or of one of its sub-units) that confers the status of distribution area to the space it occupies. Consequently, the distribution area is provided with a reality that is both ontological and genealogical, and thus, from a diachronic standpoint, it represents a sequence of spatial-temporal units (*nemophoronts*; see Zunino, 1999; 2000; Zunino and Zullini, 2004). Among these sequenced units there are relationships of contingency and also of causality: the structure, the extension and the location of each phase of the evolution of a distribution area are not totally independent of their previous stage.

This concept of distribution area derives from the consideration that complex interaction relationships are established between a species and its surroundings (the environment), and that their effects impact on the species' modifications in function of the biotic and abiotic parameters of the space that the species occupies, as well as on the modifications that the species causes in the same multidimensional space.

Léon Croizat, one of the first thinkers to realize this tight connection among space, time and what he concisely called "form", or the biodiversity expressions, provocatively synthesized this reality affirming that "flesh and rocks evolve together" (Croizat, 1962)[1].

2. THEORETICAL AND METHODOLOGICAL ASPECTS

Using and elaborating the existing data, principally from palaeo-anthropological and palaeontological sources, as well as some general concepts of Ecology and Biogeography, this analysis tries to broadly reconstruct from a theoretical framework the ecological and socio-cultural characteristics of the first human populations of hunters and gatherers that are attributed to the *Homo sapiens* species, and their possible dynamics of distribution in the various regions of the planet, after their supposed first expansion in the African continent.

In order to do so, the following considerations have been taken into account:

for what concerns **BIOGEOGRAPHICAL THEORY**

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[1] Before Croizat, only the Russian mineralogist and geochemist V.I. Vernadsky (1863-1945) had reached similar conclusions (see Vernadsky, 1926, 1945, 1999).

a) the effects of environmental anisotropy[2] on the dispersion and distribution of a taxon[3].

b) the distribution modalities of the population density inside its area (distribution area analysis) in function of the distribution of the natural resources, which the taxon needs and is able to use;

for what concerns **ECOLOGICAL THEORY**

a) reproductive strategies (*r* or *K*).

b) alimentary strategies (immediate consumption of the resources vs. food relocation and/or food hoarding), adopted by a population in relation to the occupied environment's carrying capacity – and not forgetting that the carrying capacity can vary in time and space, also in function of the environmental modifications that are set up by the population -, as well as in relation to the abiotic and biotic constraints to which the population is subjected.

Consequently, in this study the spatial-temporal evolution of human populations along ecological directrices has been correlated to their socio-cultural evolution, in order to try and determine the possible biogeographical and ecological factors that may have had an active role in the socio-evolutionary processes of the pre-historical human populations.

3. THE ORIGIN OF *HOMO SAPIENS*

There is no unanimity among researchers as regards the identification of the place and the date of the origin of our species. In the last thirty years, the debate concerning the origin of Anatomically Modern Humans (AMH) has seen two different, opposed schools of thought: one that refers to the model of multi-regional evolution (**Multi-regional Model**), and a second that follows the model of the recent African evolution (**Out of Africa Model**).

The first idea was initially diffused after 1946, when the German Palaeo-Anthropologist Franz Weidenreich developed a gradualist and progressionist model that considered the simultaneous passage of some Hominines[4] populations through three great phases (the *erectus*, the *neanderthal* and the *sapiens*), separate in the various continents from their very beginning. Following this "candelabra" model, humanity would have separately and in parallel experienced the same linear phases of evolutionary "progress" in Europe, Africa, Asia and Australia.

The hypothesis of a multi-regional evolution, sustained by Thorne and Wolpoff (1992) among others, has recently recovered this original idea. According to this hypothesis, the transformation into *Homo sapiens*, due to a common "evolutionary impulse", would have taken place in all the distribution areas of *Homo erectus* with parallel evolutions until today. In this sense, there would be lines of regional continuity in every continent: the European populations would directly descend from the Neanderthal man, renamed *Homo sapiens neanderthalensis*; the populations of Asia would descend from Peking Man, that is from *Homo erectus* groups that transformed into the archaic *sapiens* that was found in Dali; and the Indonesian and Australian populations would come from Java Man.

This regional continuity would also be confirmed by supposed morphological analogies between contemporary original populations and their fossil ancestors, which have been nonetheless criticized by many palaeo-anthropologists (Foley, 1995).

According to the followers of this hypothesis, *Homo ergaster* would have left Africa a million and a half years ago and colonized the totality of the Old World. In each region, thanks to gene flows the different populations would have gone through a parallel evolution that would have been characterized by the same phases - from

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[2] The lack of homogeneity of the constraints that are imposed to the occupier of an area in the different spatial spots. It is specifically reflected in the real possibilities that organism have to expand their areas.

[3] *Taxon* (plur. *taxa*) is a generic term that indicates a group of organisms independently from its rank, in formal classification. In Systematics, genera are taxa, as well as subspecies, species, families, etc.

[4] In the classification of Primates proposed by Goodman et Al. (2001), the family of Hominids (*Hominidae*) is formed by the sub-family *Homininae* which is divided in two tribes, the *Hylobatini* (Gibbons) and the *Hominini*. The *Hominini* tribe is also divided in two sub-tribes, *Pongina* and *Hominina*. To the first sub-tribe, *Pongina*, the genus *Pongo* belongs, whose only living representative is the orang-utan (*Pongo pygmaeus*), and in the *Hominina* we find two genera: *Gorilla*, with the only living species *Gorilla gorilla*, and *Homo*. According to Goodman et Al. (Ibid.), our species and the two living species of chimpanzees would belong to the genus *Homo* - and therefore the two chimpanzee species should be renamed *H. paniscus* and *H. troglodytes* -, as well as all the fossil taxa that in the traditional classification are attributed to the genera *Ardipithecus*, *Australopithecus* and, clearly, *Homo*. In the present paper we decided to use the term "Hominini" to indicate the taxa (also the extinct ones) of the genus *Homo*, excluding the *paniscus* and *troglodytes* species and the genus *Ardipithecus*. In doing so, the term is therefore not employed to rigorously indicate a monophyletic group, and thus a proper taxon.

ergaster to *erectus*, then to some archaic *sapiens* and finally to *sapiens sapiens* (Thorne and Wolpoff, 1992).

Quite the contrary, many researchers believe that *Homo sapiens* originated in Africa from a single cladogenetic event, not as far away in time as it had been previously thought. According to Howells (1976) and Stringer and Andrews (1988), three among the first and most authoritative exponents of the theory of the migration from Africa or of the African origin of man, our species would have been born around 200,000 years ago, and it would have not spread outside Africa before 100,000 years ago. The passage from archaic forms to *Homo sapiens* would therefore only regard Africa.

An alternative frame of thought derives from this, as proposed by Stringer and Andrews (Ibid.): a punctiform speciation would have originated *Homo sapiens* in Africa (maybe from a *H. heidelbergensis* population, or anyway from *H. ergaster* descendants), possibly in the eastern or in the southern region. After a few tens of thousands of years, the new species would have colonized the African continent, and it would have been prepared to proceed out of Africa. Starting from 100,000 years ago, it would have been distributed all over the Old World where, with different times and modalities from region to region, it would have replaced the *erectus* and the Neanderthal forms that had been living there since a long time. Apart from Africa, there would consequently not be a continuity among the present populations of the old continent and the ancient forms deriving from *H. erectus*.

In the most recent years, the theoretical apparatus on which the multi-regional evolution model is based is experiencing a situation of crisis. A permanently growing number of data, independently obtained from diverse disciplines as we shall later see, would confirm the hypothesis of the recent African origin. At the same time, according to the followers of the multi-regional model, the Out of Africa model too shows in fact some weak points. One of its postulates is that after *Homo sapiens*' origin and its dispersion outside Africa, it would have replaced all the other Hominines that used to be distributed in the Old World: this event would presuppose the existence of extremely high extinction rates, to justify the sudden disappearance of Hominines groups that had long been adapted to their environments. However, at present there is no fully plausible hypothesis that can explain the reasons of such a rapid extinction. The issue of understanding where have the other taxa of the genus *Homo* gone is indeed still open. The most credited hypothesis affirms that it has actually been *Homo sapiens* to directly or indirectly cause their extinction, as a greater development of its cognitive faculties and a more complex social organization would have allowed our species to prevail (from an ecological standpoint) on the other *Hominidae*, slowly relegating them to regions that were more hostile to their presence.

Besides this phenomenon, another hypothesis can be formed, that the *erectus* and the Neanderthal populations would have been partially "absorbed" by those of *Homo sapiens*, or that a certain degree of cross would have occurred, determining the disappearance of the genetic pool of the previous populations - smaller and less densely distributed than the latter -, and thus of their phenotypical features as well. Nevertheless, these are again hypotheses that have not undergone rigorous tests yet. "In any case, as the Out of Africa model followers like to underline, the fact that we cannot demonstrate the extinction of the other taxa of the genus *Homo* does not mean that it did not occur.

Moreover, it must also be pointed out that the opposition between the two theories on the origin of *Homo sapiens* is quite frontal, also as both have been originally created during the late 1970s as two radically different evolutionary epistemologies. They are two alternative visions of the evolutionary process that find their roots in the defence, or in the discussion, of the fundamental postulates of Modern Synthesis" (Pievani, 2002)*[5].

On one hand, there is a model that is in syntony with the principles of phyletic gradualism, and on the other, a model that agrees with the theory of the punctuated equilibria. Quite briefly, according to the hypothesis by Eldredge and Gould (1972), species remain relatively stable during long periods, and at their end, if they do not extinguish, they encounter rapid crises of variation, characterized by speciation and the appearance of new organization models; cyclically, new periods of long stasis would follow and be followed by rapid variation periods.

This theory, that had already been formulated by Léon Croizat (see Croizat, 1962), opposes the idea of a slow and gradual evolution, which is shared by orthodox

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[5] The English translation of this and the other the quotations with * was specifically made for this essay by Francesca Zunino.

Darwinists. For the latter group, in fact, evolutionary dynamics have a prevailing continuative and cumulative character (phyletic gradualism). According to this idea, until recently species like *Australopitecus afarensis*, *H. habilis* and *H. erectus* used to be considered successive stages of an anagenesis process, or of modification through descent, that through several slow changes would have led to the formation of our species.

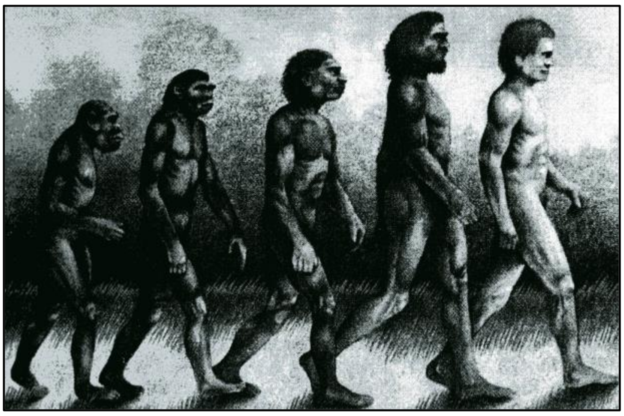

Figure 1. "The march of human progress": canonical representation of the evolution of *Hominidae* according to the gradualistic vision of Darwinian derivation.

Moreover, from current palaeo-anthropological data it is quite evident that *H. sapiens* is the product of **adaptative radiations**[6] that occurred in very rapid geological times, and that brought the formation of a number of taxa of Hominines in Africa, through **cladogenesis** processes[7]; these taxa would have secondarily spread in different regions of the planet.

In order to better understand this process, it is necessary to remember Erwin's **theory of taxon pulse** (1981), referable to the concept of "taxon cycle" already present in Darlington (1943) and formalized by Wilson (1961). Erwin starts from the premise that generally every phyletic line (and every phyletic branch in its ambit) undergoes a cladogenesis and adaptative radiation process that will end in the extinction of the formed systematic groups.

This theory, greatly influenced by the punctuated equilibria, implies the idea that evolution occurs in space with the alternation of periods of relative stasis and periods of intense differentiation and expansion. With "taxon pulse" it is therefore intended (Fig. 2) the evolutionary change in geographical space, starting from a centre of origin (primary or successively secondary) that a phyletic line of organisms undergoes along simultaneously spatial and ecological directrices.

For what concerns this paper, the theory of taxon pulse can be applied, together with other evolutionary biogeography concepts that shall be addressed later, both to interpret the dynamics that led to the formation of a still imprecise number of taxa of Hominines, including *H. sapiens* and, at an intra-specific level, to understand the formation of the diverse human groups that we know today – the latter being the central focus of this paper.

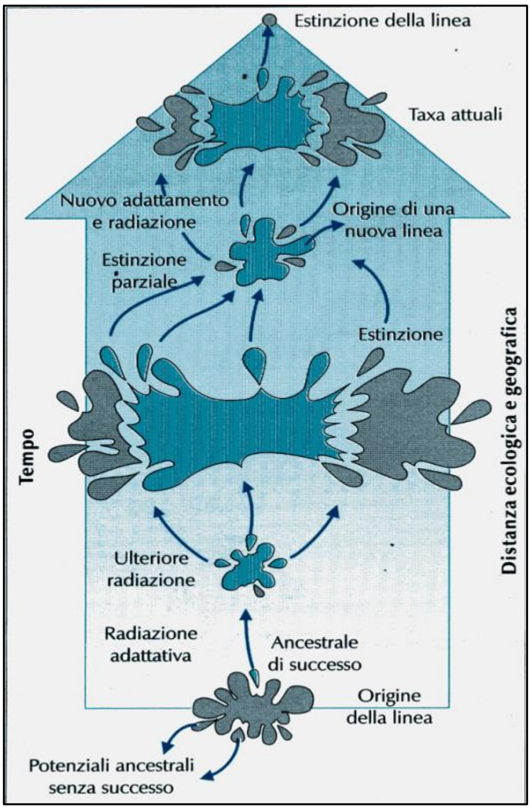

Figure 2. Generalized scheme of the phenomenon of taxon pulse (following Erwin, 1981, modified by Zunino and Zullini, 2004).

4. THE EXPANSION OF *HOMO SAPIENS*

Before macroscopically reconstructing *Homo sapiens*' general routes of expansion, from its probable appearance

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[6] A series of events in the evolutionary history where an ancestral species origins different descendant species, adapted to different ecological scenarios. Consequently, in an adaptative radiation the many descendant species seem quite different compared to their ancestral. Generally, adaptative radiations occur in specific geographical regions, usually in a relatively short geological time.

[7] Process of genealogical differentiation of the taxa.

in Africa (200,000-100,000 years ago) to its complete colonization of the globe, it is useful to examine which are the principal characteristics of our species that allowed us to adapt to the most diverse environments, and to occupy the majority of the terrestrial surface. From a strictly biological point of view, *Homo sapiens* is a stenothermic species and it is only adapted to warm climates. Our species was able to expand its distribution area only thanks to the artificial microclimate it has learnt to create using its cultural skills, which actually makes it an eurithermic species.

Moreover, thanks to both his physical qualities and even more to his cultural skills, man has proven to have an excellent **vagility**[8]**,** already during the earlier stages of his dispersion on Earth. This has allowed man to realize long displacements by land, sea and recently also by plane, in relatively short times. Therefore, *Homo sapiens* has practically overcome all obstacles against its dispersion, and if we consider its total process of expansion (since the appearance of man until today) we could affirm that human populations spread very rapidly on the terrestrial surface.

Nevertheless, with this way of thinking we could underestimate the effects of **barriers**[9] and, more generally, of environmental anisotropy on man's distribution on Earth. There is also a risk of not discriminating among the different attitudes that human populations have had as regards environmental discontinuity. In fact, not all populations adapt to a particular type of environment, and not all of them possess the same vagility. It is not useless to remember that the highest densities of the *Homo sapiens* populations are generally found, even today, in the sub-tropical and temperate areas, and in environments with high seasonal productivity.

It is consequently probable that since his appearance in Africa, man would have at first occupied climatically and productively favourable areas where he would have densely distributed, and that in a subsequent time he would have occupied less favourable lands, due to a further and unsustainable increase (for those times) in population density.

Recent works by Lahr and Foley (1994), Cavalli-Sforza, Menozzi and Piazza (1997), Klein (1999), Stringer (2000), Walter et Al. (2000) and Underhill et Al. (2001) on the pre-historical migrations of *Homo sapiens* may confirm this hypothesis. With archaeological and palaeontological data, Lahr and Foley particularly proposed a **"multiple dispersions" model** (1994) that implies two great migratory flows from Africa, in keeping with the Out of Africa model. According to these authors, even before 60,000 years ago a preferential coastal route of dispersion existed, that from the Red Sea, through Arabia reached south-eastern Asia. During those times, due to the ongoing glaciation, the sea level was lower and the emerged surface of the continents was greater than today. Particularly, Arabia was joined to Africa at the present Strait of Djibouti (Fig. 3).

According to a different hypothesis (Klein, 1999), the most consistent dispersion of Anatomically Modern Man from Africa would have occurred with one great migratory event, only around 50,000-45,000 years ago, and the preferential dispersion route would have been through the Near East (the Levantine route). However, the unearthing of archaeological finds that can be referred to Anatomically Modern Man in Southern Australia, dating from around 60,000 years ago, could lead to the hypothesis of a more ancient dispersion from Africa through the coasts of the Red Sea.

The starting point of the first *Homo sapiens* migratory wave can be maybe found near the Eritrean site of Abdur (Fig. 3), which is 125,000 years old and has recently been uncovered (Walter et Al., 2000). During this phase, many human populations would have prevalently exploited marine resources (evidently, as they were very abundant), and this would explain their distribution along the Eastern African, the Arabian and the Indian Ocean coasts in the Late Pleistocene (Fig. 3). It must be noted that the oriental limits proposed by Walter *et Al.* (Ibid.) for the first human population expansion phase out of Africa correspond to the Wallace line.

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[8] In Biogeography, *total vagility* is the possibility that living beings have of spreading in space according to their of dispersal power, both active and passive, which is a characteristic of every species or biological form. For what concerns man, it is evident that at least in historical times the component related to passive dispersal has drastically reduced its importance. In this paper, human vagility is intended as man's capacity of moving in space, also in the anisotropic space, and even also of going beyond possible barriers.

[9] A barrier is an environmental discontinuity, highly effective in the prevention of the living beings' dispersion.

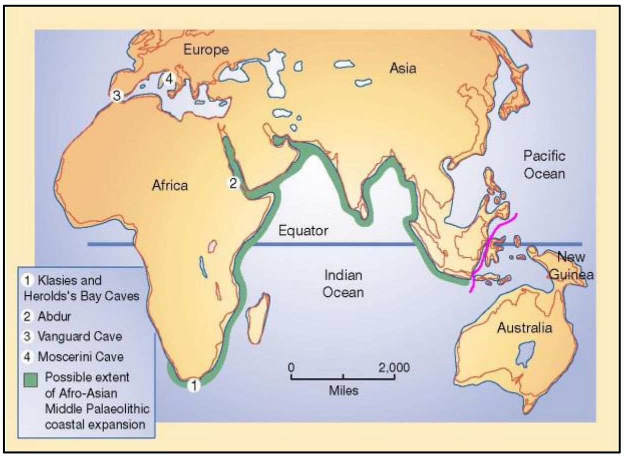

Figure 3. The Old World as it would have appeared during the Late Pleistocene (around 65,000 years ago). In red, the present coastal lines. In green, a hypothetical dispersion route of AMH from Africa to Asia. In purple, the Wallace line (from Stringer, 2000, modified).

Later, around 50,000-45,000 years ago, the populations that had arrived to south-east Asia would have reached New Guinea and Australia; during the same period a second migratory wave from Africa would have arrived in Egypt, and moving northward of the Red Sea it would have reached the Near East and Anatolia, and from there Europe (35,000 years ago), settling then down in central Asia. Afterwards, other populations would have migrated from central Asia to India, Pakistan and Japan (around 30,000 years ago), and others would have reached northern China and Siberia. After that, some Siberian populations would have crossed Beringia and colonized North America in several waves (at least 12,000 years ago), and quite rapidly all the American continent to Patagonia. Simultaneously, the farthest Pacific islands would have been reached as well, thus completing the planet's colonization.

5. THE SOCIO-CULTURAL EVOLUTION

While it was possible to correlate archaeological and palaeo-anthropological data to other data from different fields (particularly, from Biomolecular Genetics and Linguistics) and to obtain satisfactory results in order to reconstruct the first human populations' expansion process, the reconstruction of our species' social evolution seems more difficult. First of all, there is a lack of agreement among researchers concerning the definition (less arbitrary as possible) of the characters that could indicate *Homo sapiens*' passage from a non-modern to a modern behaviour.

Secondarily, although the efforts of field research on tracing pre-historical sites have multiplied in recent years, the archaeological and palaeo-anthropological documentation seems insufficient for a well-founded understanding of the socio-evolutionary human process. Moreover, a great disproportion exists between the number of studied sites in Europe and in the Near East (two regions where archaeological researches have concentrated for different historical and "ideological" reasons), and of those located and examined in Africa, Asia and America.

Due to the insufficiency of data and the methodological controversies, today's situation sees two opposite currents of thought.

One side of the researchers (Binford, 1985, 1989; Mellars and Stringer, 1989; Klein, 1989, 2000; Diamond, 1992; Noble and Davidson, 1991; Tattersall, 1995; Bar-Yosef, 1998) affirms that some *Homo sapiens* populations developed a behaviour that could be defined as modern since possibly 50,000 years ago. According to these authors, the appearance of modern behaviour would have occurred quite rapidly after a long phase in which *Homo sapiens*' behaviour would have not been very different from that of the other species of the genus *Homo*, with which *H. sapiens* had been coexisting together for a period.

The causes of the sudden movement towards modernity would be due to the development of a more complex and articulated language, to a possible structural re-organization of the brain, and to a consequent increase in the cognitive faculties. The phenomena of the development of microlithic technologies, the use of flint and of bone instruments, a greater vagility, the establishment of long-distance commercial exchanges, a better specialization in hunting, and particularly the intense exploitation of aquatic resources, and the use of pigments for decoration purposes, would all be related to a fast growth of the social complexity that occurred in some populations.

As the first fossils that can be attributed to modern man, *Homo sapiens sensu stricto* (found in Africa and in the Near East), date back to more than 100,000 years ago, the hypothesis of the Human Revolution or of the "Great Leap Forward" – two expressions that usually indicate the rapid movement towards modernity - creates a temporal vacuum between the appearance of *Homo sapiens*' modern anatomy and the emergence of the so-called modern behaviour. In other words, the followers of the Human Revolution hypothesis believe in a separate origin of modern anatomy, that appeared around 150,000 years ago, and of modern behaviour, that would have only started 50,000-40,000 years ago. The supporting data principally derive from researches on pre-historical lithic finds[10].

From the lithic documentation, in fact, it would seem that the cultural forms remained relatively unvaried and uniform during the Middle Pleistocene, as both *Homo sapiens*' and *Homo neanderthalensis*' lithic industries were of the Mousterian type (Mode 3). Later, around 45,000-30,000 years ago, a sudden increase in social complexity would have occurred, in several population that were distributed in Europe, but that were native of north-Eastern Africa, a region from where populations had spread all over the planet through the Near East and central Asia, as it has been previously affirmed.

Starting from this period and throughout all the rest of the Late Pleistocene, the lithic industries rapidly improved and gained specific characteristics in the different regions of the Old World, coherently with the biotic and abiotic characteristics of the occupied environments. In Europe in particular, simultaneously with the arrival of the Cro-Magnon populations, the Mousterian technology was replaced by the **Aurignacian** (between 35,000 and 27,000 years ago). Successively, both in Europe and in the western Asian regions more sophisticated lithic industries appeared: the **Gravettian** culture (between 27,000 and 22,000 years ago), the **Solutrean** (between 22,000 and 18,000 years ago), and the **Magdalenian** (between 18,000 and 10,000 years ago) (Mode 4 and Mode 5). It is quite easy to understand that the followers of the Great Leap Forward admit that there may have been some discontinuity in the socio-cultural evolution of our species: more or less longer periods of relative technological (and therefore cultural) uniformity would have followed and would have been followed by times of fast growth of complexity.

On the other hand, the interpretation offered by other authors is rather different, as it maintains a greater graduality in the socio-cultural evolution. Researchers as Lahr and Foley (1998) and McBrearty and Brooks (2000) affirm that many of the innovative characters that are used to indicate the Human Revolution can be found in the African records from the Middle Stone Age (between 100,000 and 60,000 years ago). These characters would not have appeared suddenly, all together and in the same area, but in sites that are largely separate in space and time. Regarding this issue, according to McBrearty and Brooks (2000:453):

"*This suggests a gradual assembling of the package of modern human behaviours in Africa, and its later export to other regions of the Old World*".

Furthermore, the two authors also add:

"*If aspects of modern human culture in Africa were developed by hominids using existing cognitive capabilities and transmitted by cultural rather than by genetic processes, the most likely scenario would be an accretionary process, a gradual accumulation of modern behaviours in the African archaeological record. This change needs not be unidirectional or confined to a single location. Rather, we might expect innovative behaviours to appear at different times and different regions.*"
(Ibid. :456).

In our opinion, there are elements of both hypotheses that should be taken into account. This means that these two different visions do not necessarily exclude each other, and that there is probably a middle way between the two alternatives. Following Lahr and Fowley (1998) and McBrearty and Brooks (2000), we are convinced that complex societies and the modern cultural characters evolved in Africa (and not all the authors following the Human Revolution hypothesis seem to affirm the contrary; see for example Tattersal, 1998), and from there they were exported to the rest of the world. However, the fact that spatially and temporally separate (and isolated) populations existed in Africa may realistically signify that each of these populations underwent independent evolutionary processes, which brought to a different socio-cultural complexity level coherently with the ecological and biogeographical constraints. It is indeed from this premise that this paper starts its analysis, as we

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[10] The lithic finds classification that is hereby referred to was proposed by Clark (1968). He offers a classification based on the way in which the lithic instruments have been manufactured.

are convinced that the study of the evolution of the first human populations can gain a great benefit from the application of concepts and methods that are nowadays well-established in the study of all the other living beings.

6. BIOLOGICAL AND SOCIAL EVOLUTION: THEORETICAL PREMISES AND RESEARCH HYPOTHESES

We think that a correlation exists between the spatial-temporal evolution of human populations along specific ecological directrices and their social evolution – the latter manifesting itself through a great diversity and complexity of cultural forms, particularly between the end of the Pleistocene and the beginning of the Holocene.

Following this premise, we believe that the separation and differentiation process (principally cultural) of the first *Homo sapiens* populations, and thus their social evolution, can be interpreted in a micro-evolutionary scale using the same theoretical and methodological apparatus (opportunely modified) with which some researchers are trying to explain the macro-evolutionary dynamics of biological systems and the diversity of the species today. In particular, we refer to the dynamics that were proposed by Croizat's Panbiogeography, and to the ideas of Eldredge and Gould with their theory of punctuated equilibria. These are two visions that originated in generally different theoretical and methodological contexts, but that in our opinion seem perfectly compatible. According to Léon Croizat (1894-1982), the father of Panbiogeography, biogeographical areas go through two phases, once or more times: a phase of mobility and one of immobility (Croizat, 1958). During the mobility phase, under favourable conditions and in absence of barriers, the organisms and the biota [11] expand their distribution areas, while during immobility, once they have reached their maximum expansion limits, which are determined by geographical and/or climatic barriers, the distribution areas fragment so that the species tend to vary and to differentiate at the passing of time. Therefore, the result would be the formation of new species through vicariance. Nevertheless, for Croizat fragmentation is principally due to the formation of intermediate barriers of ecological or geographical nature. Also, in man's case, due to his characteristics and his recent origin, it is evident that the fragmentation phenomena are largely caused by active dispersion events. In any case, during *Homo sapiens*' most precocious history, fragmentation phenomena of the distribution area due to climatic variations are hypothesized, that would have determined an early important differentiation of human populations (see Lahr and Foley, 1994; 1998).

7. THE CONCEPT OF HUMAN POPULATION UNIT

The idea is to treat the human population units as if they were separate species, albeit with the due cautiousness. In the context of this paper, as *human population unit* we intend:

a group of individuals (of variable number) distributed on the same area (of variable measure) that has an endogamy rate significantly superior to its exogamy rate, that cooperates in an organized way in the production systems, and that preserves systems of communication, of knowledge, of values and of traditions through time that are common and more or less exclusive in function of the efficacy of the geographical and linguistic-cultural barriers to which the group is subject.

Therefore, as it enjoys some level of internal cohesion, a human population unit interacts in a relatively unified and independent way with the environment, and with the other population units. For what concerns man, however, the specific character of a population unit would not have been caused by biological factors, but by cultural factors[12], as from the end of Pleistocene to the beginning of Holocene the deep geographical isolation and the diversity of the occupied natural environments favoured a differentiation process of the human populations, both from a morphological and mostly from a linguistic - and therefore, a socio-cultural - point of view.

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[11] All the existing species in a specific geographical area. Each area therefore is characterized by a specific biota (defined by the species and not by the biological forms). For example, although New World's vultures look a lot like those from the Old World and perform a similar biological role, they are nonetheless phylogenetically closer to storks than to the Old World's vultures. They are two different species as well as two different orders.

[12] Incidentally, it is the cultural factor, apart from the geographical, that favours some degrees of reproductive isolation.

8. THE EVOLUTION OF HUMAN POPULATION UNITS IN THE GEOGRAPHICAL SPACE

Referring to the general concepts of Panbiogeography, it is possible to formulate the hypothesis that the first human populations, during their evolution (from their initial expansion in the African continent), would have experienced, once or more times, the following phases[13]:

1) a **phase of dispersion** (or **mobility phase**) in a relatively isotropic space (correlated to demographic growth), that would have lasted until the limits of maximum expansion, marked by geographical and/or ecological barriers, were reached. During this phase, the distribution area of a population would have expanded;

2) **phase of equilibrium** (or **immobility phase**) where, once the limits of maximum expansion had been reached, a population would have then located in a specific area (or *geographical region*) for a determined period of time. In this phase, the distribution area would have remained more or less stable.

As it will be discussed later, the occupation of the distribution area by a generic population is almost never homogeneous (Fig. 4), due both to the environment's anisotropy (dishomogeneity of the constraints imposed by the occupier in different points), that must never be disregarded, and to the demographic dynamics of the occupier (Zunino and Zullini, 2004).

Therefore, considering a relatively vast area, a hypothetical human population could distribute in space among a certain number of population units, more or less isolated from a geographical, cultural and reproductive standpoint, and eventually subject to different ecological factors. The population units' distribution and dimension would reflect the distribution of the natural resources that they need and that they are able to use: generally, where resources are densely distributed, a high population density as well as relatively big population units can be observed. On the opposite, to a scarce distribution of resources would correspond a low population density and smaller population units. The population units' characteristics and roles that can be found following this criterion will be discussed further on.

The condition of the stability of a population's distribution area (considered as the sum of the distribution areas of the single population units) could last for quite a variable time. Afterwards, the distribution area could be subject to contractions, or to a more accentuated fragmentation (as it already appears partially discontinued, see Figure 4), or also to a further expansion beyond the barriers, whose final result would be in any case a fragmentation. Moreover, as it will be discussed, the expansion of population units could also occur inside specific environmental discontinuities. These events are coherent with the evolution of the distribution area of each population unit, taking into account that even just one population unit of quite great dimension could be distributed in an area or geographical region. In this case, the conceptual difference between "population" and "population unit" would really be rather subtle.

The occurrence of the previously described phases would be linked to factors that are intrinsic to population units (demographic factors), or to extrinsic factors (principally, climatic-environmental factors), or to both. The phenomenon of fragmentation could therefore occur:

a) through the formation of intermediate barriers of ecological and/or geographical nature

or, more often, in *Homo sapiens*' case,

b) through a process of active dispersion of population units or sub-units beyond the already existing barriers, that would determine a disjunction of the distribution area or its complete **displacement**. If the human population units, once the barriers are overtaken, found ecological conditions that were equivalent to those of their origin, they could start another phase of dispersion, and after reaching new expansion limits, another phase of stability, eventually followed by a new phase of active dispersion.

The repetition of these movements would have quickly determined the colonization of the most favourable environments for our species from a productive and climatic perspective, and it would have also favoured a differentiation process of the human populations within

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[13] What follows implies the acceptance of an historical concept of "distribution area" as a sequence of spatial-temporal units (nemophoronts), among which there are relations of contingency and also of necessity.

similar biomes[14] (for example, in savannas and the coastal environments, rich in marine resources). On the other hand, not all the population units colonized favourable environments, as for reasons that can be linked to intra-specific competition some of them often occupied less hospitable environments, like deserts, the Arctic regions, and to some extent the forests. These populations would have isolated themselves more from the others, and differentiated in a greater way, particularly from a socio-cultural and ecological standpoint.

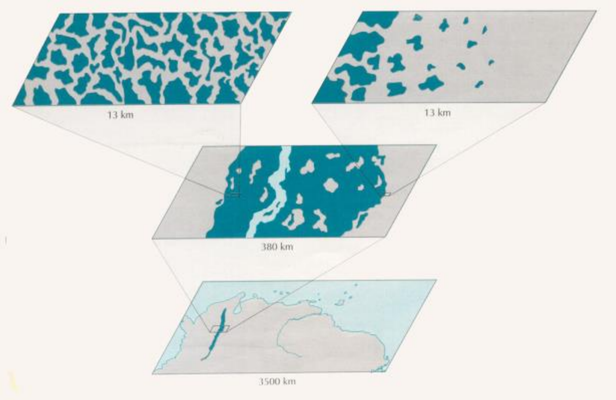

Figure 4. A distribution area can be seen as more or less homogenously occupied, according to the observer's "resolution power". To different scales, in fact, a distribution area can appear to be homogeneously occupied, or more or less discontinuously (from Zunino and Zullini, 2004).

9. THE EVOLUTION OF HUMAN POPULATION UNITS AS COMPLEX SYSTEMS

According to our hypothesis, human population units seem to have not only evolved in space with similar logics to the species, but as men aggregate and constitute social systems or societies due to their nature, population units seem to have also evolved and to still evolve as complex systems. In fact, it is principally the fact that it represents a complex and relatively autonomous social system that gives a population unit a specific value, in relation to the unified and particular characteristics that the system expresses.

The tendency towards aggregation among groups and later among greater and greater population units favoured the origin of very complex adaptative social systems, that were capable of reproducing themselves and to self-organize thanks to the high information content (social knowledge) that had been accumulated and elaborated by the individuals, and that was being culturally transmitted to the new generations over time. As a matter of fact, according to Morin (1973:78), a culture constitutes:

"*a system that generates high complexity without which this high complexity would be destroyed in favour of an inferior organizational level. In this sense, culture must be transmitted, taught, learnt, and reproduced in every new individual during his learning period to be able to self-perpetuate, and to also perpetuate its high social complexity*"*.

Social systems, just like ecosystems, would be characterized by a cycle (cyclical evolution) where the phases of growth-equilibrium-dissolution-reorganization would alternate (Marten, 2001) (Fig. 5).

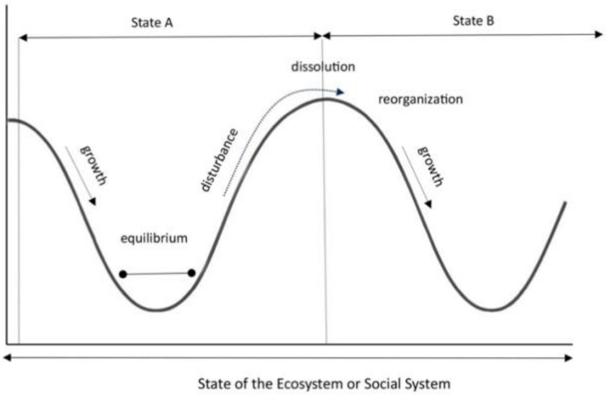

Figure 5. Cycles of complex systems like the ecosystem or the social system (from Marten, 2001, modified).

During the growth phase, that would be characterized by *positive feedbacks* (forces promoting a change), the social system would become more complex and would expand, after the numeric increase in its component parts, and thus after the establishment of a greater number of inside connections. As regards space, we could observe a phase of enhancement of the distribution area. A rapid scientific, technological and ideological development would correspond to it, leading to the consolidation (in the equilibrium phase) of some social paradigms – therefore

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[14] The group of ecosystems (fields, rivers, forest, etc) that, because they occupy the same climatic zone, presents similar living forms and a certain degree of environmental coherence; they have a relatively unified trophic network, and recognizable bio-geochemical cycles (for example, the tundra, the Mediterranean macchia shrubland, the tropical rainforest and the savanna).

also of scientific paradigms *sensu* Kuhn (1962) -, or even of the predominant *Weltanschauung* within the system. In the equilibrium phase, that is characterized by negative feedbacks (forces that are opposed to change), the social system would get to a "climax" value of complexity and of internal organization. In space, a phase of stability of the distribution area would be observed in this case.

The conditions of equilibrium would remain until the following causes intervened, conjunctively or disjunctively:

1) an external interference to the system (for example, drastic climate variations or enemy invasions);

2) a collapse of the system from the inside (for example, an increase in population density that provokes the collapse of the ecological and productive system).

When these events occur, the major or minor dissolution of the social system depends on its resilience, that is on its power of reacting to internal and external perturbations and of minimizing their damages, as well as clearly on the intensity and duration of the interference. Also, the property of resilience would be correlated to the information level that the social system has, and to its internal cohesion degree; these are two characteristics that would measure its organizational efficiency and its adaptative skills. Briefly, if a social system was not able to react to a perturbation, it would be totally dissolved, and in some cases extinguished, and these events would determine a deep contraction of the distribution area.

On the other hand, if the system's resilience was high, after a more or less marked dissolution phase the system could reorganize and start a new phase of growth, and thus another cycle. In some cases, reorganization would coincide with the research of new areas to be exploited, also in farther spaces from the origin. In space, a "dispersal" phase of the distribution area would be observed, followed by a new phase of dispersion.

"*An efficient society is able to function during all the four stages of the cycle. An efficient society does not only work based on the ongoing state, but it is also able to face all the conditions that are associated to the following stages*" (Marten, 2001:72).

The interaction between a human population and the environment where it is distributed should therefore be interpreted not just as the sum of each individual's interactions with the environment, but as the interaction of a social system with an ecosystem. All the parts of the social system (the individuals) are integrated in such a way that they allow the system to behave like a functional unit that favours survival. Due to the interconnections among all parts, each part's behaviour is controlled by feedback mechanisms – positive and negative – on which the development and the change of the whole social system depend.

"*Society and individuality are not two separate juxtaposing realities, but a double system exists where in a complementary and contradictory way the individual and society become integrant part of each other in a symbiosis relation*" (Morin, 1973:41)*.

Furthermore, we have voluntarily not set a dimensional limit to human population units, as they could be formed by only a few groups of individuals more or less related to each other and distributed in a small area, but they could also be constituted by groups of thousands of individuals in very large areas. Consequently, social systems as well can have a variable scale (in function of the space and of the reciprocal relations among individuals) that goes from the family nucleus to the total human population (as it seems to be happening today).

In addition, the social structures that *Homo sapiens* inherited from the previous lines of Hominines (which had also been inherited from an ancestral primate) were already complex structures, constituted by groups whose numeric dimension was much greater than the single-family group.

Therefore, although the family nucleus is considered by many as an elementary form of society, within our species it would not represent the ancestral form from which the most complex social systems that we know today originated. *Homo sapiens*' family structure, when it is recognizable in its general terms, seems to have already been well integrated into the structure of the whole social system, and thus it would not have been autonomous from it. As many data show, *Homo sapiens*' family structure would have been modelled according to the constraints imposed by the social system. Consequently, *Homo sapiens* was already born a highly complex social species.

To be more precise, it was the complexity reached by a line of previous Hominines to determine the origin of our species. “We are used to the idea that our psychology and our anatomy ‘descend’ from the primates’, and we have to get used to the idea that the same occurs for what concerns our social body.” (Moscovici, 1972:221; quoted in Morin, 1973:51)*.

10. HUMAN LANGUAGE AND SOCIAL COMPLEXITY

It is now useful to ask ourselves why other species of the genus *Homo* (*H. erectus*, and particularly *H. neanderthalensis*), although being doubtlessly characterized by a high social complexity and an efficient productive organization, surrendered to our species. In other terms, the question is why *Homo sapiens* prevailed over the other two species with which he had been living for some time, remaining the only species of its kind. For many researchers, there is no doubt that one of its decisive advantages was its greater power of articulating language, a characteristic that allowed our species to become even more complex from a social perspective.

“*The high degree of the Anatomically Modern Human’s adaptation, that allowed him to demographically and geographically expand, could be due to a greater power of communication, that is to a higher level of linguistic ability. The development of greater linguistic skills could have been the most relevant process in the evolution of AMH, that possibly coincided with either the transition from archaic to modern man, or with the period of AMH’s ripeness, between 100,000 and 50,000 years ago,* […], *or also with both periods*.” (Cavalli-Sforza, Menozzi and Piazza, 1997:123)*.

Some necessary but not exclusive conditions for the origin of language were a series of genetic modifications that determined the anatomo-structural reorganization at the skull and the neck levels (lowering of the larynx, extension and arching of the pharynx, and consequent rounding up of the skull basis that embraces it), and at the thoracic case level, so that it would have allowed the emission of highly modulated sounds through the newly formed apparatus. At the same time, at the level of the central nervous system, the qualitative and quantitative growth of the cerebral volume favoured the formation of areas in charge of language.

Additionally, after what has been hereby said, it must be necessarily hypothesized that the development of such complex inter-individual communication systems as human languages would have presupposed a similarly complex social organization, that would have generated the need for an unequivocal and quick exchange of information among an increasingly high number of individuals, linked by specific production relations. Following this perspective, articulated language would have probably evolved in populations that were formed by a high number of individuals, among which the information flows must have been very elevated. In fact, it is difficult to believe that articulated language developed in population units whose dimensions corresponded to a band society, formed by 15-80 individuals. Also, if it is true that language development promoted a greater vagility and a vast geographical expansion of the populations that had adopted it, the growth rates of these populations must have been very high, as their rapid expansion in a great part of the planet, with a mechanism that is similar to that of the “invading” species, could not otherwise be explained.

11. THEORETICAL ASPECTS OF BIOGEOGRAPHY AND HUMAN ECOLOGY

As it has previously been outlined, considerable mass or individual displacements occurred (and still occur) in human history. Overall, these displacements are called **migrations**[15]. Migrations are determined by factors of repulsion (emigrations) and of attraction (immigrations), respectively from and towards a specific geographical area:

Repulsion factors. A local increase of population density (that can determine an environmental collapse) or drastic climate variations, both reflecting a deficit of resources, can act as repulsion factors, as well as wars, famine or epidemics.

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[15] Following a recent use, under the term “migrations” we will include both the displacements implying the abandoning of an area (correctly, emigrations) and those that imply the invasion of a new area (correctly, immigrations), and thirdly also eventually the cyclical (seasonal or non-seasonal) cycles that should be properly called migrations.

Attraction factors. The determination of looking for new areas, even just for opportunistic reasons, can instigate the attraction to zones where migrants believe to be able to improve their conditions.

Nevertheless, there are no direct relations between the possible attraction factors displayed by specific areas and the repulsion factors that other areas may show. Quite the opposite, potential attraction factors can drastically boost their efficacy when repulsion factors from another area occur. In any case, we think that migratory flows that are caused by repulsion factors are not only more intense compared to those determined by opportunistic reasons - which often involve narrow social levels and not entire (or almost) population groups -, but they also developed first in the evolutionary history of man, before the migratory flows with attraction factors. The modalities through which men move in the geographical space are the same as those that more generally involve every living being. These modalities can be divided into two types:

Dispersion: phenomenon consisting of a gradual expansion of a population in a demographic growth phase and in a constraints-free space.

Dispersal: non-gradual migratory phenomenon that implies overtaking a barrier, and that only involves one part of a population. In this case, after migrants acclimatize and settle in a new area, they can lose their contact with the population and the area they come from, and go towards a geographical and genetic isolation. In the case of *Homo sapiens*, geographical isolation can lead to cultural isolation.

Moreover, a particular case of dispersal + indigenation (or acclimatization), that is known as *Biogeographical Pollution* (Zunino, 2003), occurs when:

"[…] *a propagulum from a single species of living beings, that evolved in a specific biogeographical context, reaches a* <u>*biota*</u> *that is different from the original one and settles there, causing a more or less important condition of unevenness*." (Zunino, 2003).

For what concerns man, some populations behaved as a "*polluting propagulum*", and more often, they consciously or unconsciously favoured the introduction of species from a different biota in the new areas of settlement or in areas with which they have had commercial relations, with their dispersion and mostly with goods' transportation (see Masseti, 2002). In the majority of cases, the introduction in an area of even just one new species (or better, of the *propagulum* of a species), belonging to a different biota, caused strong imbalances and deep environmental modifications.

Dispersion, and in some cases dispersal too, represent the result of an increase in the number of the individuals in function of the **carrying capacity**[16] of the environments that are being colonized. For our species as well, one of the theoretical limits to population growth, at least during the first *Homo sapiens* expansion, was therefore given by the carrying capacity of the natural environment in which the populations lived. More generally, the limit to growth depends on the availability of space and resources, in both quantitative and qualitative terms. Then again, this is an unfixed, variable limit, in time and in space.

Particularly, for what concerns man:

***ceteris paribus*, the environment's carrying capacity varies in function of the possibilities and skills that men have of increasing it, modifying the natural environment for their own advantage.**

Human populations, and particularly those adopting a marked *r* strategy, use positive entropy processes to optimize the net production (yield) of the ecosystem. They are facilitated, in fact, by a ratio of $P/R > 1$, where P = net production and R = respiration (waste metabolic products). This implies a reduction of diversity and of information in the natural ecosystems, that determines their return to immature states, characterized by high entropy levels. For example, this is the case of the *slash and burn* practice, still very used to prepare forest soil for agriculture or pasture, or of the immense use of fire as a hunting strategy by the first hunter-gatherer African societies (Harris D.R., 1980). In general, it can be affirmed that apart from exceptional cases human activity has

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[16] Maximum number of individuals of a population that can survive in a given environment (limit beyond which the exceeding population could not survive).

always been in contrast with the ecosystems' natural tendency towards an evolution to more or less durable dynamic equilibrium stages, which are characterized by a low entropy level and a high information level.

Consequently, the faculty of increasing the carrying capacity of the environment depends on:

1) **the information level** that men have about the environment in which they live, and that they culturally transmit and elaborate, from generation to generation, in real time - that is, in extremely short times compared to the genetic transmission of information;

2) **the ecological potentiality**;

3) **the quantity and type of labour force** that is being used for production, following socially organized modalities.

12. THE EFFECT OF ENVIRONMENTAL ANISOTROPY ON THE DISPERSION AND DISTRIBUTION OF HUMAN POPULATIONS

The ecological space is covered by a network of discontinuities (geographical, climatic, biotic), that cause it to be heterogeneous (Zunino and Zullini, 2004). This lack of uniformity is reflected both on the ways and times in which the resources are distributed in space, and on the greater or smaller ease with which they make themselves available to men. In fact, the presence of barriers, predominantly of the geographical type, prevents the dispersion and, *a fortiori*, the dispersal of human populations in space.

Consequently, environmental anisotropy has the effect of conditioning human population units' real possibilities of expanding their distribution area in the geographical space, imposing constraints on the modalities and times of the individuals' and the groups' habitual displacements. The "curvatures" of space (for example, mountains or a city's buildings) lengthen the time of travel between two points of the terrestrial surface, thus making them farther apart. In fact, in a non-Euclidean space (such as our surroundings), the shortest way between two points is almost never represented by a line segment. Consequently, apart from an aerial displacement, the time factor will be more important than the space factor for practical results.

Furthermore, it is helpful to mention that:

"[…] *living beings do not only move in the absolute spatial dimension, but also in a particular 'temporal' space. For man in particular, a type of space exists that geographers define as 'social'. Independently of other factors, two localities are more or less socially near in relation to the quantity of matter, energy and information exchanges. Thus, such exchanges create historical, economical, linguistic and cultural links. This deforms our space perception, as it often creates the impression of a shortening of the distances among entities which are linked by intense economic and administrative relations. It can therefore happen that many people from Turin and Milan can believe to be farther away from London (or from Holland) than from Catania, due to an illusion that is induced by the political borders. The spatial context in which man lives and operates is not therefore just the 'absolute', Euclidean space, but it is the intersection of the latter with the temporal, the economic and the social space.*" (Zunino and Zullini, 2004:125)*.

13. BARRIERS AND ENVIRONMENTAL DISCONTINUITIES

In Biogeography, the concept of barrier does not have an absolute value, not even when it is applied to the study of the distribution of human populations. For a number of species, a highly efficient environmental discontinuity can act like a barrier; for other species, the same discontinuity can be a **corridor**[17] and can favour their dispersion. As concerns a species or a system of living species, the effectiveness of a barrier can be measured, therefore, according to some parameters, among which there are above all:

a) **the nature of the barrier**;

b) **its porosity** (homogeneous efficiency of the barrier), that can be variable in time and can also not be symmetrical;

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[17] A territory that allows the biotic inter-change between regional units that would be otherwise separated by barriers.

c) **the vagility** that characterizes the populations that interact with it in a given period.

Also, an environmental discontinuity can represent a potentially new environment to colonize (as long as there is adaptation). In this case, its effectiveness would depend on:

d) **the extent of ecological opportunism** that the populations that would eventually penetrate its territory would show[18].

While the parameters **a** and **b** depend on factors which are intrinsic to environmental discontinuities, **c** and **d** depend on factors that are intrinsic to populations. So under the same conditions (concerning the barrier's nature and effectiveness), different human population units could have the tendency to interact with an environmental discontinuity in different ways, in relation to their vagility and/or to the degree of ecological opportunism they have. Hence, a barrier can represent an obstacle to the expansion of a population unit that could be easily overcome, but the same discontinuity can also be a new environment where some units can adapt to live.
In fact, some high-effectiveness environmental discontinuities (such as for example a desert or a mountain chain) certainly constituted barriers for some human populations, or at least they were territories that could not be used from a trophic perspective, and thus unsuitable for settlement; for others, that vice versa found a way of making use of them for sustenance purposes, they were colonisable areas. Additionally, high-effectiveness environmental discontinuities (such as a wide sea channel or strait) were insurmountable obstacles for some human population, while others developed suitable technologies to overtake them, and the barriers became dispersion routes towards new areas.

As a result, the questions that we wish to answer can be summarized as follows:

1) Why did some human populations develop a greater ability to overtake barriers than other populations?

2) Why were some populations, showing a greater ecological opportunism, able to adapt to the barriers, therefore actually increasing their species' niche?

According to our hypothesis, for what concerns human population units, both vagility and the ecological requirements are strictly related to the density of the population, to the production mode that the population is able to perform, and thus to its social organization.

It must be specified that in this paper "production mode" (or economy) ***is an expression that includes all the reproductive, alimentary, commercial and military strategies that a human population unit adopts in order to optimize its use of the area resources (and, more generally, in military and/or economically controlled areas), or in areas that are "politically" close, with which the unit performs exchanges of commercial resources***. Conclusively, ***the production mode describes the ecological characteristics of a human population unit***.

14. THE DISTRIBUTION OF THE POPULATION DENSITY INSIDE ITS AREA

In order to test our hypothesis, it seems useful to start with a few general biogeographical concepts that regard the analysis of the distribution area of a species, and particularly of the way in which the population density is distributed inside its area, according to its phase of equilibrium - that is, when the width of the distribution area remains a more or less stable for a specific period of time - or of expansion.
From the analysis of the distribution areas of different species (Rapoport, 1975), it can be affirmed that:

under conditions of area stability, and disregarding the possible effects of environmental anisotropy, a species typically has a homogeneous density in the central fraction of its distribution area, that is in the fraction

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[18] It is worthy to remember that some barriers can act like *absorbing barriers*, particularly if they are very large. They allow population groups that have penetrated inside them to find sites with compatible conditions to the original ones, sometimes even extremely similar, which can promote a stable settlement (for example, an oasis in a desert). In order for this to happen, nevertheless, the barriers must be internally anisotropic and their margins must have some degree of porosity (Zunino and Zullini, 2004). Moreover, the potential area to be occupied must be dimensionally congruent with the minimal numeric consistency of the population stock.

where the resources used by the species are densely and abundantly distributed, and they also are of good quality. On the other hand, density tends to more or less regularly decrease in the frontier belt, where population units are smaller and more scattered (Fig. 6-A). During the process of expansion of the distribution area, moreover, population density abruptly enhances in the peripheral belt, that is in the area immediately behind the "front lines" of the frontier belt (Fig. 6-B).

The same analysis can also be carried out at a population level, and particularly it can be extended to human populations. When the distribution area is in an equilibrium phase, a human population (for example, an ancestral African population of hunters-gatherers) would be more densely distributed in the sector where the resources are more concentrated, whereas the population density would decrease as it got closer to the frontier of the distribution area, in function of the quantity and quality of the available resources at all times.

As a result, it seems useful to distinguish between two classes of population units:

Class A. It is formed by the population units living in the fraction of the distribution area where good quality resources are densely and abundantly distributed (zones with a high carrying capacity);

Class B. It is constituted by the units living at the border of the distribution area, and generally in zones with reduced carrying capacity.

When biotic and abiotic conditions vary inside the distribution area, the two above-described classes of population units would be subject to substantially different ecological constraints, that could also be reflected in different reproductive and subsistence strategies. If the distribution area was very big and the environmental anisotropy was less negligible, it would be possible that the two classes of population units could be more or less isolated, both geographically and culturally. In many cases, one or more population units could be forced to isolation for reasons of competition for the resources. Access to zones where alimentary resources are more abundant could in effect be denied to a part of the population. Consequently, one or more units would be forced to occupy marginal areas with poor resources. Besides, it could also occur that, after an enemy invasion, some population groups that had been initially distributed in areas rich in resources would be forced to take refuge in the less favourable and more isolated areas, found in the peripheral belt of the distribution area.

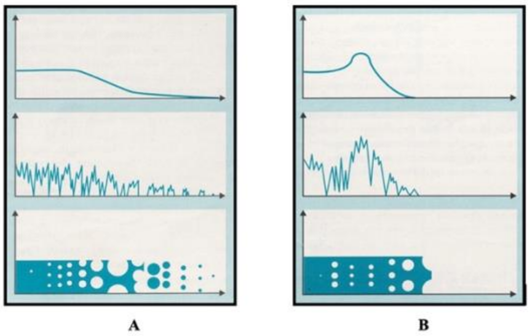

Figure 6. Three different ways of representing the frontier territory of a distribution area in an equilibrium phase (A) and in an expansion phase (B), following Rapoport (from Zunino and Zullini, 2004, modified).

15. HUMAN POPULATION UNITS DISTRIBUTED IN THE HIGH CARRYING CAPACITY ZONES (CLASS A), AND IN THE PERIPHERAL BELT OF THE DISTRIBUTION AREA (CLASS B): DIFFERENCES IN THEIR PRODUCTION MODE AND SOCIAL ORGANIZATION

Let's suppose that our hypothetical ancestral human population has occupied an area where food resources are abundant, but only in a specific season of the year and in a relatively limited site. From this, it derives that during the abundance season some individuals would tend to concentrate in the highly productive site, while others would be more or less excluded and would distribute around the favourable site with a decreasing density as they got closer to the boundary of the distribution area. In the fraction with the highest population density, and consequently with the most intense information flow among individuals, population units could have a more structured and rigid production system than the units living at the border. This production system would be characterized by a greater labour division - and by a greater labour force - inside the group (as a consequence of a greater number of individuals), and by a precise social organization that could be functional for example to the adoption of a particular group hunting strategy.

On the other hand, in the peripheral territories of the distribution area where individuals are subject to a greater environmental stress, a smaller environmental carrying capacity (reflected in a smaller population density) would correspond to a less structured and more flexible production system. The latter would be based not so much on collective organizational capacity – like in the highest population density areas - as on the individual adaptative and subsistence abilities.

- Class A. It is probable that the individuals occupying the seasonal site (initially in a semi-nomadic way) would be favoured by social aggregation and cooperation processes. Since in a specific season the quantity of available resources is higher than that period's effective necessity, the individuals would be more interested in the hunting yield (fishing, gathering), in order to use the food resources surplus during the unfavourable season.

For what concerns hunting or fishing, for example, it is clear that if the activity was carried out by a high number of individuals, with a well elaborated tactic and with specifically created tools, it would allow a greater prey yield (and most of all of greater dimensions) than what the same number of individuals would obtain if each of them hunted or fished alone, or in small and scattered groups. The organization and cooperation of many individuals would therefore guarantee a greater yield of resources in this area that would benefit the entire population unit, as well as the possibility of having enough food for the whole year – yet under the condition of having developed food conservation techniques (see Testart, 1982).

Moreover, as the greatest labour effort would be concentrated in one season, for the rest of the time (during scarcity periods) population units would dedicate themselves to the organization of recreational activities and ritual ceremonies (Ibid.), as well as to the observation, the study and the manipulation of the natural environment in order to enhance their margins of exploitation. This would therefore result in population groups with a high internal cohesion and an elevated information flow among individuals – these are two characteristics whose importance would increase with the acquisition of a more sedentary lifestyle.

Additionally, there is a third characteristic of these population units that in some way constitutes their limit: the rigidity of their productive system. Concerning this issue, Testart (1982:524) notes that:

"*In the storing economy, planning plays a crucial role. The seasonal establishment of food stores is central to the economic cycle; an abundant harvest and the adequate handling of the product for preservation are both essential for the survival of the community until the next harvest. If the products deteriorate over the time or if winter lasts too long, famine threatens the community*".

In the sites with high seasonal productivity, the population units' productive system would be highly specialized, and the role of each individual (relative to the work he performs) would be functional to the type of social organization that allows the exploitation of that specific natural environment in the ways we have described. If the high seasonal productivity remained more or less constant in time, and if the social production was efficient, the population unit would grow, reinforce its identity and consolidate its production mode. The group would be very interested in maintaining this privileged condition, and thus in defending the occupied site from possible competitors and/or predators or raiders. Hence, it would have a markedly territorial character (Dyson-Hudson and Smith, 1978), and consequently a category of individuals (the warriors) could be created, with the specific task of ensuring the territory's defence (and, if needed, of occupying with force or raiding other spaces).

- Class B. For what concerns the population units that occupy the peripheral belt of the distribution area, or a sector that does not have the same favourable characteristics as the high seasonal productivity sites, let us suppose that a limited quantity of alimentary resources would be found in their area, which would nevertheless be constant all year round. The main characteristics of these population units would be similar to those of the nomadic hunters-gatherers, well known in literature. They can be summarized as follows:

a) low population density
b) an economy mainly based on immediate consumption of alimentary resources
c) different alternative strategies for environmental exploitation
d) greater ecological opportunism.

The social structure of these groups would be less complex than the structure that has been previously described for the population units with a high seasonal productivity and the most flexible productive strategy. Therefore, these individuals would be able to tolerate a wider range of environmental variations, as their subsistence would not be linked to a specific production mode. Also, individual abilities in these groups would be equal, the internal labour division would be scarce (each individual would be in fact indispensable for hunting, gathering and for war activities), and a category of specialized individuals would not exist.

16. "FORCED" AND "SPONTANEOUS" AGGREGATION

The process of aggregation among the population units that are distributed in the high carrying capacity area (Class A) could also occur in a non-peaceful way, that is without a silent agreement of cooperation and labour division ("*spontaneous*" *aggregation*[19]) among the groups. Between two population units, competition for one or more resources could prevail on cooperation and exchange.

In such a case, a population unit could be successful over the other, and this event would favour an emigration process towards the most isolated zones of the distribution area by the defeated individuals that would have survived, as well as a "forced" aggregation process of the winner population unit and the eventually imprisoned or subjected individuals among the defeated. These individuals could be used as labour force (more or less gratis) in the production processes, or the fertile women only could be used to increase the number of births, to reinforce the group and to guarantee its survival (especially if it has had numerous losses during the conflict).

Therefore, we believe that the practice of raping the defeated population's women by the winning males after the end of a conflict is very ancient, and that its basic aim is avoiding inbreeding[20] excess inside a population (particularly during the first phase of *Homo sapiens*'s history, in which the isolation among human groups was very high).

On the contrary, when good relations prevailed between two or more population units, that could be promoted for example by a mutually favourable resources exchange, it would probable that the gene flow would be guaranteed by practicing inter-group unions. This would also facilitate a greater consolidation of the cooperation and trade relations.

17. *r* AND *K* STRATEGIES

The ***r*** and ***K*** types describe a complex model of reproductive strategies towards which animal and vegetal species and/or populations can be selected. In fact, the selection towards an *r* or *K* strategy can occur at both an inter-specific and intra-specific levels (Rapoport and Drausal, 1979; see also MacArthur, 1972; Gadgil and Solbrig, 1972). The idea of the *r* and *K* strategies was originally proposed by Dobzhansky (1950), and later by MacArthur (1962) and by Cody (1966). Soon after, Mac Arthur and Wilson (1967) proposed the "*r* and *K selection*" terminology, which was rapidly adopted by many ecologists and evolutionists.

The two strategies relate to two mathematical models of population growth that are constructed in function of the availability of resources that a population has in a given area:

Model *r*. *Model of population growth in a given area where resources are so abundant that they can be considered as "limitless", and therefore there is no competition among individuals to obtain them.*

Model *K*. *Model of population growth in a given area where resources are limited and where there consequently is a strong competition among individuals*.

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[19] Two or more population units could spontaneously aggregate also to defend their respective territories from the invasion of groups with a greater military force. For example, at the end of the XIX century several Zulu tribes united, even forming a State, against British invasion of South Africa. In spite of the great technological and military difference between the two armies, the British Empire suffered one of the most severe defeats of its history during the Anglo-Zulu war at Isandlwana, Rorke's Drift and Ulundi in 1879.

[20] The cross of blood-related individuals.

18. MODEL *r*: EXPONENTIAL GROWTH

In the first case, population growth will be completely determined by its intrinsic natural growth rate (***r***), that represents the growing power of a population under ideal conditions (it is a measure of a population's biotic potentiality). The mathematical formula representing this model is:

$$Nt = N_0 e^{rt}$$

Where **N(t)** is the population size at time **t**, **N0** is the initial population size, ***r*** is the intrinsic growth rate, **and** is the basis of natural logarithms.

This equation describes an exponential growth model that is typical of the populations that have just invaded a new favourable environment.

On the other hand, it is evident that no population can grow exponentially forever. Sooner or later, it will encounter forms of environmental resistance that will restrain its growth.

The populations following the exponential growth model (a *J* curve) are mainly regulated by abiotic factors such as climate in their growth, and as the effect of those factors is independent of the population density, this model is also known as "Density-Independent"[21].

19. MODEL *K*: LOGISTIC GROWTH

In the second model, population growth will be regulated in function of the environment's carrying capacity (**K**) that represents the maximum number of individuals of a given population that can survive in a specific environment (a limit beyond which the excess population could not survive). In this case, competition among individuals will be strong, and growth will be regulated by factors depending on population density (logistic or density-dependent growth model, an *S* curve).

The mathematical formula that represents it is the following:

$$dN/dt = rN_o\ (K\text{-}N0/K),$$

where ***r*** = intrinsic rate of natural growth; N_o = number of individuals at time **t** = 0; **K** = carrying capacity of the environment. The $(K - N_o/K)$ factor is what decelerates population growth (*inertia factor*).

In the natural world, some species or populations have the tendency to maximize the values of *r* (***r* strategists**), others to maximize the values of *K* (***K* strategists**). The r strategists operate under a high density-independent mortality rate, while *K* strategists function better under high density-dependent mortality rates. Namely, *r* strategists are good reproductors, while *K* strategists are good competitors (highly efficient) and they are capable of self-regulating in order not to exceed the limits of their environment's carrying capacity.

20. CHARACTERISTICS OF *r* STRATEGISTS

They are found in:

a) unstable environments,
b) environments where resources are abundant and easily accessible,
c) environments where there is a low inter-specific and intra-specific competition,
d) environments where a regulation that is independent of density prevails;

they have:

e) high values of *r*
f) a good dispersion power, and they are rather able to flee from local disasters
g) a short generational time, and a rapid development
h) a quick ontogenetic development, and reproduction at a precocious age
i) a short life

and they are:

j) opportunists and invaders, that is good colonisers,
k) poor competitors.

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[21] On the other hand, it is also true that for this type of population high density could favour the spread of infective illnesses, which could in turn determine a drastic reduction of the individuals. In this case, not unusual in the natural world, growth would be regulated by a density-dependent biotic factor (the pathogenic agent).

21. CHARACTERISTICS OF K STRATEGISTS

They are found in:

a) more or less stable environments
b) environments with limited resources, and difficult to access
c) environments with a high inter-specific and intra-specific competition
d) environments with a prevalent density-dependent regulation
they have:

e) low values of *r*
f) poor dispersion power
g) a long generational time and a slow development
h) a slow ontogenetic development, and reproduction at a late age
i) a relatively long life

and they are:

j) not good colonizers
k) excellent competitors

It is important to underline that there is always a principle of relativity that must be taken into account (Rapoport and Drausal, 1979) as regards both *r* and *K* strategies. For example, the two species' characteristics could be those typical of the r strategists, but one species could be more *r-selected* than the other, or some populations within one species could be *r-selected*, while others *K-selected*, or even more so, at a given time a population could be r-selected, and later *K-selected*, and vice versa. And finally, a population could have *r-strategist* characteristics as concerns some aspects, and *K-strategist* characteristics as regards others.
Generally, *r* and *K* are not absolute categories, they represent in fact two ideal limit conditions, opposed to each other, and between which a series of intermediate conditions can occur in function of the carrying capacity of the environment. There is no absolute condition of "white" or "black", but a range of shades between the two.

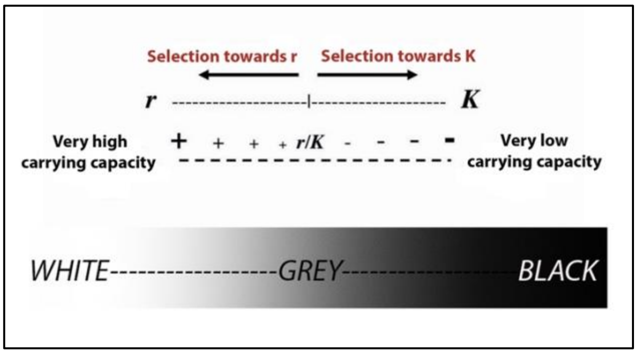
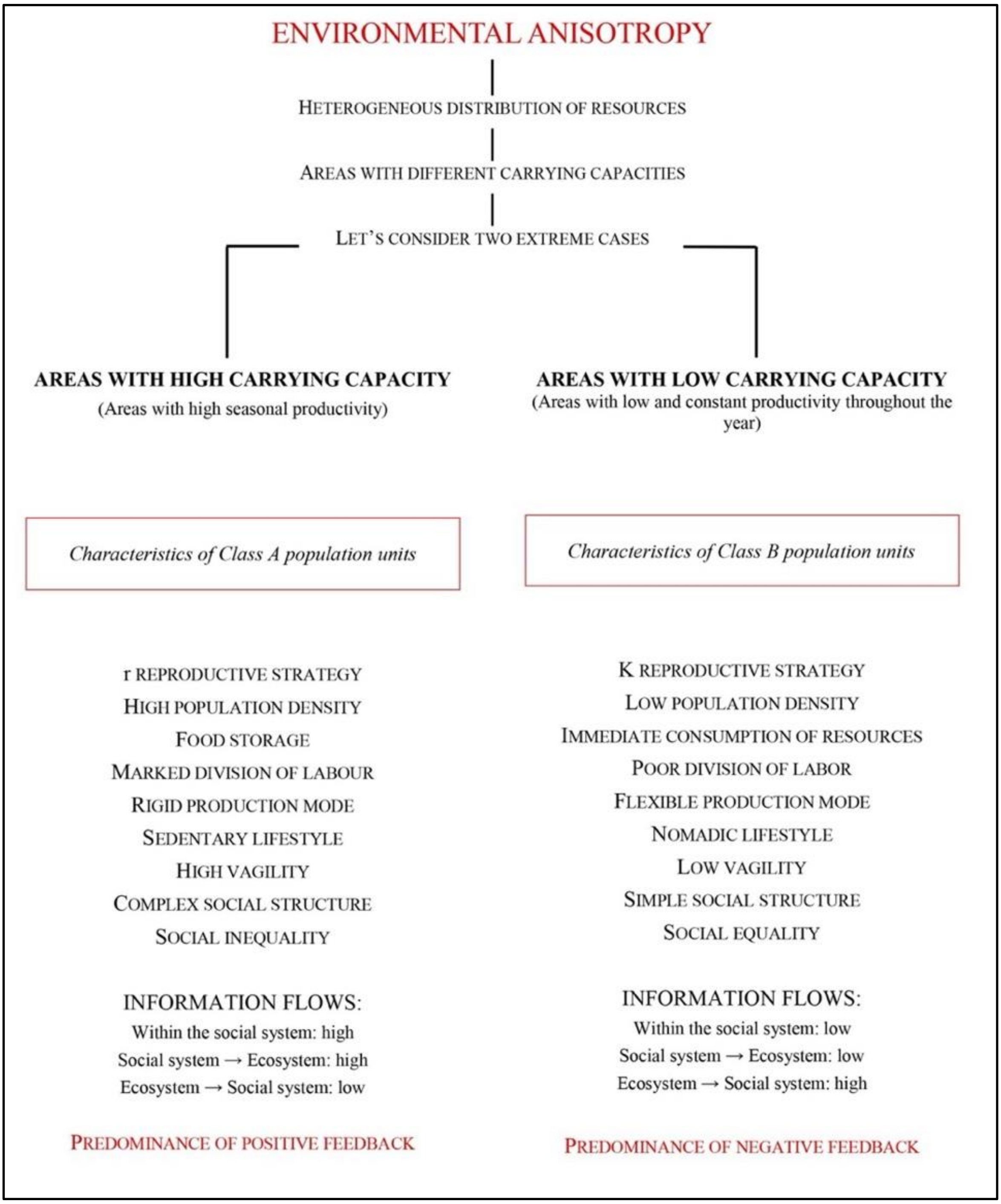


Fig. 7. Relationship between the carrying capacity of the environment and r and K strategies

If this principle of relativity was not considered, it would be difficult to profitably apply the model of the *r* and *K* strategies to human populations.

22. HUMAN POPULATIONS AND *r* AND *K* STRATEGIES

In the most recent literature that we examined, there are only a few explicit references to *r* and *K* strategies to describe the ecological characteristics of the populations of hunters-gatherers in the Late Pleistocene. However, the characteristics of the two above-discussed classes of population units, Class A and Class B, seem to refer to those of r-strategist and *K-strategist* populations respectively. It is probable that at a certain time in their evolution Class A population units (what we consider *r* strategists) were able to reduce their infant mortality rate and ultimately their density-independent mortality factors. For what concerns African hunters-gatherers in the Late Pleistocene, McBrearty and Brooks hypothesized that infant mortality and a general mortality reduction could have been favoured by the acquisition of new technologies and by commercial exchanges with distant areas (McBrearty and Brooks, 2000:532).
The high growth rate of these units would not therefore have been counterbalanced by a high mortality; this would have favoured high density populations, as well as the tendency to reach the limit of the environment's carrying capacity and the total depletion of the basic resources. At this stage, the population units would have used their high dispersion power (vagility) and their ability of colonization to occupy new and ecologically compatible areas.



ENVIRONMENTAL ANISOTROPY

HETEROGENEOUS DISTRIBUTION OF RESOURCES

AREAS WITH DIFFERENT CARRYING CAPACITIES

LET'S CONSIDER TWO EXTREME CASES

AREAS WITH HIGH CARRYING CAPACITY (Areas with high seasonal productivity)	**AREAS WITH LOW CARRYING CAPACITY** (Areas with low and constant productivity throughout the year)
Characteristics of Class A population units	*Characteristics of Class B population units*
r REPRODUCTIVE STRATEGY	K REPRODUCTIVE STRATEGY
HIGH POPULATION DENSITY	LOW POPULATION DENSITY
FOOD STORAGE	IMMEDIATE CONSUMPTION OF RESOURCES
MARKED DIVISION OF LABOUR	POOR DIVISION OF LABOR
RIGID PRODUCTION MODE	FLEXIBLE PRODUCTION MODE
SEDENTARY LIFESTYLE	NOMADIC LIFESTYLE
HIGH VAGILITY	LOW VAGILITY
COMPLEX SOCIAL STRUCTURE	SIMPLE SOCIAL STRUCTURE
SOCIAL INEQUALITY	SOCIAL EQUALITY
INFORMATION FLOWS:	INFORMATION FLOWS:
Within the social system: high	Within the social system: low
Social system → Ecosystem: high	Social system → Ecosystem: low
Ecosystem → Social system: low	Ecosystem → Social system: high
PREDOMINANCE OF POSITIVE FEEDBACK	PREDOMINANCE OF NEGATIVE FEEDBACK

Fig. 8. If we consider areas with different carrying capacities, this figure shows the characteristics of human population units with a prevalent r strategy, and units with a prevalent *K* strategy.

23. FOOD RELOCATION AND FOOD HOARDING

Another factor that could have favoured a reduction in the mortality rate of the first *Homo sapiens* populations has to be searched in the food storage practices, or more appropriately in the behaviours that are known as food relocation and food hoarding in Ethology. They both are strategies that are directed towards delaying the moment of food consumption and towards food conservation through special procedures[22]. We can highly hypothesize that some food conservation techniques have been precociously developed in the evolution of *Homo sapiens*, although it would be difficult to demonstrate it through direct evidence.

During the Late Pleistocene, in fact, fire was already being skilfully used by African hunters (Harris D.R., 1980), therefore it is not excludable that food smoking could have already been practiced in those times. It must be noted that *Homo sapiens* is the only species among Primates that practices food accumulation:

"*The lack of hoarding in primates is surprising given the propensity of aboriginal and modern man [...] to store a diverse array of food types. Our proclivity to store food would suggest that primate ancestor may have stored food to varying degrees and that this habit would have been preserved in many extant species, however, this does not seem to have been the case*" (Vander Wall, 1990:225).

In any case, to test whether such behaviour represents a new character (*apomorphy*) of our species, with an adaptative value we should have a deeper knowledge of the extinct Hominines species' behaviour, which is obviously not an easy task. Some of the few available data, derived from the study by Lieberman and Shea (1994), hypothesize that the seasonal use of resources in the Near East was one of the few characters that distinguished the occupation of sites attributed to *Homo sapiens* from the sites attributed to *Homo neanderthalensis*. Anyway, as it will be later shown in this paper, even before the starting of agricultural practices, food storing and the deriving sedentarization were already part of the lifestyle of some hunter-gatherer populations.

24. SAVANNA-WATER INTERFACE

Apart from food storage, another important factor that could have promoted relatively high growth rates in the first *Homo sapiens* populations can be found in the characteristics of what represents the optimal climatic and productive environment for our species. This is the environment that some units learnt to exploit at its maximum, the savanna-water interface in the Intermediate Tropical Zone:

"*Ecotones between savanna and closet-canopy forest, and between savanna and water, have been favoured areas for human occupation in all savanna regions. The savanna-water interface – along the coast, around lakes, along stream courses, and around swamp margins – has played a crucial role in the human ecology of savanna environments because the presence of water and the availability of aquatic resources tends to mitigate seasonal stresses arising from fluctuations in rainfall, plant growth, and the behaviour of terrestrial animals.*" (Harris D.R., 1980: 31).

Studies by Crawford (1992), Chamberlain (1996), Broadhurst et Al. (1998) and Crawford et Al. (1999) showed that the Omega-3 polyunsaturated fatty acids are essential for the brain development of young mammals. The authors hypothesized that scarce availability of these lipids in a terrestrial environment is the main responsible factor for the limited brain growth of the terrestrial megafauna. These lipids, such as the Arachidonic acid, are absent in plants but found in minimal quantities in the animals that live on dry land excluding their brain tissue, which contains up to 600 grams of lipids per Kg. Instead, the marine fauna is particularly rich in such lipids, so that the brain growth of marine mammals is less limited. Crawford et Al. (1999) maintain that access to marine food has been essential for the development of present-day human brain, and that the evolution of *Homo sapiens* started in the savanna-water interface.

Therefore, it is not a case that the first effective dispersion of human populations outside the African continent was a movement along all the coast of the Indian ocean. It must not be excluded that groups that specialized in fishing (distributed near the sea) and groups that were specialized

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[22] A specification is needed: *food relocation* and *food hoarding* are not synonyms, as food relocation can and can also not be followed by food hoarding, whereas in some cases there can be food hoarding without relocation (Zunino, 1991).

in the hunting of big animals (distributed in the inland savanna) would exchange the products of their activities. This would have favoured the growth of population density and also the local depletion of resources, both *primus movens* of the process of dispersion.

25. THE LATE PLEISTOCENE HUNTERS-GATHERERS

In the general literature, two different types of hunter-gatherer societies are distinguished (Grosse, 1896; Testart, 1982): the first is characterized by a low level of social complexity and low population density; the second, by a high social complexity and high population density.

Testart (1982) hypothesizes that the radical difference between these two types of societies lies in the different economies that they imply: the first is based on the immediate use of food resources, whereas the second is based on "large scale seasonal food storage" (Ibid.). He then adds that:

"[…] *where some natural food resources are* ***bountiful*** *but* ***seasonal****, they can be gathered 'en masse' while available and stored* ***on a large scale*** *once transformed through appropriate food preservation techniques, thus becoming the staple food year-round. This possibility lies at the intersection of four conditions, two ecological (abundance and seasonality of resources) and two technical (efficient food-getting and food-storage techniques).*" (Ibid. :523).

The adoption of the latter economic type would have favoured a semi-nomadic lifestyle (and later sedentary) and high population densities.

For what concerns the first phenomenon, on one hand food storage reduces the *possibility* of mobility, and on the other it reduces its *necessity*. Therefore, populations will have the tendency to settle in one area for a more or less stable time, at least until the abundance of basic food resources is granted. The second phenomenon could be considered a consequence of both abundance of resources and a sedentary lifestyle (Ibid.). Sedentary life allows in fact the reduction of the time separating the births of two sons (Hassan, 1973).

Based on archaeological findings, Clark (1980) affirms that the Middle Stone Age populations living in the tropical savanna (including some regions of the Congo basin and Western Africa) were essentially hunters of great preys, particularly of gregarious Bovines, while in Ethiopia they hunted animals such as elephants, hippopotami and giant buffalos. He also affirms that:

"*It can be projected that group organization consisted of a number of mobile kin-related units, who recognized the existence of a common bond and came together seasonally into larger aggregates.*" (Ibid.:50).

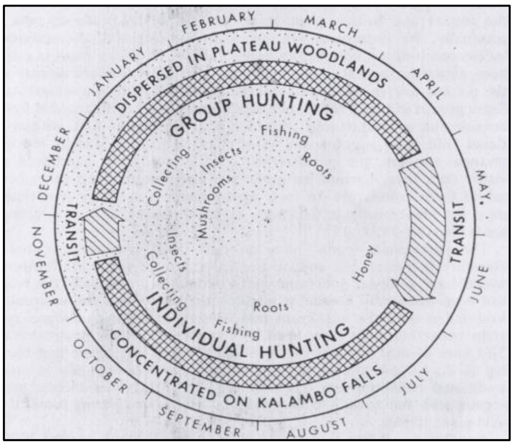

Figure 9. Subsistence model of the prehistorical hunters-gatherers and their seasonal movements at Kalambo Falls, Zambia. The rain season lasts from November to March, the dry season from April to October. During the rain season, group hunting is performed, and individuals form great aggregations. During dry seasons groups disaggregate and individual hunting is practiced (from Clark, 1980).

Binford (1968) notes that during the hunting and gathering age some areas tolerated a higher population density than other neighbouring territories, as they had a greater quantity of food resources, and thus a higher carrying capacity. Particularly, K. W. Butzer describes some types of biomes that would have had an optimal carrying capacity for hunter-gatherer populations of the past:

"*the grassy, tropical deciduous woodlands and savannas; the mid-latitude grasslands;* [and] *the lower latitude Pleistocene tundras*" (Butzer, 1964,).

For what concerns the Near East, for example, it would seem that mixed oak forests of the Levant Coast would have supported a greater number of individuals than the inland steppe zones during the Late Palaeolithic (Flannery, 1968). We can therefore think of:

"*a mosaic of "optimal" habitats, with a somewhat higher carrying capacity and population density, separated by "less favourable" habitats with a somewhat lower carrying capacity and population density*" (Binford, 1968).

26. BINFORD'S EQUILIBRIUM MODEL

After Wynne-Edwards (1962) and Birdsell (1966), Binford (1968) postulates that, once adapted to a specific environment, the prehistoric populations of hunters tended to be stable in time, with a lower density than the density that would have caused the depletion of resources. He states that their adaptation could have changed only if a disturbance of the equilibrium had occurred between the populations and their environment.

According to Binford, two types of disturbance can operate:

1) *a change in the physical environment that could cause a reduction of the used food resources*;

2) *a local increase of the population to the limit of the carrying capacity of the environment*.

Nevertheless, Binford states that from a theoretical standpoint it is preferable to refer to the second type of disturbance to explain a possible adaptative change, as it does not confide in the *deus ex machina* of climate change. In fact, according to the author, climate change can not explain all the cultural changes that occurred during Prehistory (see also Cohen, 1977).

From this presupposition, Binford (1968) hypothesizes that a source of stimulus for cultural change could be the cyclical demographic pressure that is applied on the low carrying capacity areas by the individuals coming from high carrying capacity zones. The latter would represent the regional centres of growth: it is here that the population tends to increase, and it is from these areas that individuals are forced to emigrate before the limit of that environment's carrying capacity is reached. This means that the high carrying capacity zones would be *source areas*, whereas the neighbouring territories, with low carrying capacity, would represent *recipient areas*.

According to Binford, it is in the marginal *habitats* that the demographic equilibrium can often be disturbed by the immigration of population groups from *source* areas, which pushes population density towards the limit of the environment's carrying capacity. Hence, Binford suggests that the stimuli to the exploitation of new alimentary resources could be stronger *around the borders* of the population growth centre, and not in the actual centre.

Binford's equilibrium model has been applied (Flannery, 1968) to explain the movement from a hunting and gathering economy to an economy based on agriculture, that in the Near East occurred around 10,000-8,000 years ago. However, in our opinion the above discussed model seems to describe just a phase of a more general process that, in different places and times, has periodically involved human populations, from the moment of the globe's colonization by modern man onwards.

In effect, Binford's model describes the moment – after a strong demographic growth, localized in the most favourable fractions of the distribution area[23] – in which the groups of individuals or the population sub-units that have been forced to abandon their sites once their subsistence's favourable conditions stopped would move to the peripheral belts of the distribution area. During this phase's climax, the graphic parameters of the distribution area would be modified, and a high demographic density would be noticeable at its borders (see Rapoport, 1975).

Nevertheless, what does not appear to be clear in Binford's hypothesis is the consequent effect of the overlapping (if it occurs) of the expanding population units and of those that already occupy the peripheral belt of the distribution area (for Binford, the margins of the growth centres). Following the author's model, we would think that reaching the carrying capacity limit at the margins of the growth centres would be due to the increase of density, generated by the overlapping of the individuals coming from the source and the recipient areas. From this, the stimulus to the exploitation of new food resources and to cultural change would derive.

In spite of this, overlapping is not a necessary condition to admit the reaching of that specific environment's carrying capacity, and in fact overlapping does not always occur (see Rapoport, 1975:35). A high number of individuals

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[23] In fact, an expansion or a displacement of the distribution area of one or more population units occurs.

from the most internal fractions (with high carrying capacity) would form an advancing frontline towards the limit zones of the distribution area, where the carrying capacity is lower *per se*, and thus it is already at its limit for the population at the frontline.

For this reason, it would not be the demographic pressure caused by the overlapping of the population units from the two classes (A and B) to produce the disequilibrium between the population and the quantity of food resources; it would be the fact that a high density (that developed in zones of high carrying capacity) causes the occupation of a low carrying capacity area.

At this point, under an unstable equilibrium condition, and thus in a transitory phase, the expanding population units (Class A) would face two alternatives (although not exclusively, as it will be later seen):

1) the most immediate**, emigration**. Emigration can be successful when possibly unpopulated areas are reached, which are located beyond the barriers constituting the limits of the distribution area of origin, and with favourable conditions;

2) **a change in productive strategy, and an increase of the environment's carrying capacity**. Around 10,000-8,000 years ago, a productive strategy change was necessary in the Near East, as it was not possible to decrease the demographic pressure moving to uninhabited areas anymore, and as some environmental discontinuities were hardly surmountable for those populations. Before that change, however, starting from around 20,000 years ago, those populations had carried out the so-called "*broad spectrum revolution*" (see Hole and Flannery, 1967; Flannery, 1968), an expression that indicates all the different subsistence strategies within the hunting and gathering production mode that some populations adopted to react to the deficit of optimal alimentary resources (mostly big mammals), that were abundantly available before.

27. A POSSIBLE EXPANSION MODEL

We have therefore already hypothesized the role that population units from productively favourable areas and far away from the peripheral belts of the distribution area would have had, but ***what would the role of the populations that were already present in the marginal territories have been? Why is overlapping not certain?***

In our opinion, in order to answer the previous questions, the fact that the two classes of population units or sub-units that could possibly come into contact constitute social entities with different adaptations and productive organizations must be pointed out. Following Binford (1968) and Cohen (1977), we think that demographic pressure (that in our opinion acts in the high seasonal productivity area) must be considered the main factor determining the imbalance between the population units and the environment they live in. In fact, the abundance of food resources and the adoption of a more or less sedentary lifestyle would support on one side the increase of the population density, and on the other an ever-expanding production efficiency. The latter, representing a positive feedback, would then lead to an even greater increase of the population density, until the limit of the environment's carrying capacity would be reached.

In order to redefine the concept of "population pressure", Cohen (1977:50) affirms that:

"*It is here defined as nothing more than an imbalance between a population, its choice of foods, and its work standards, which forces the population either to change its eating habits or to work harder (or which, if no adjustment is made, can lead to the exhaustion of certain resources)*."

Once the favourable conditions of production disappeared because of the excessive exploitation of food resources, the population units (or parts of them) would be forced to leave their seasonal site.

As according to our hypothesis this is an incipient phase of *Homo sapiens*' process of expansion, it is quite probable that after moving to the borders of the distribution area, these populations would have chosen to emigrate in search of another favourable site that they would have believed to find after overcoming some barriers. In fact, doing so they would not have the necessity of radically changing their productive strategy. Therefore, these groups' priority would have been the re-establishment of their efficient production mode somewhere else, as it allowed them to maintain high population densities. The high internal cohesion of the group, a greater level of material culture and of project ability compared to the units living in the peripheral belts of the distribution area, as well as an efficient labour organization would be the preconditions for undertaking a long travel to the other side of the barriers.

During the phase of demographic increase, the individuals coming from the most internal zones (who would have constituted an expansion front) would have gradually moved towards the territories that were located in the peripheral belt of the distribution area, where they could have come into contact with the population units living in that area.

Considering the clear numeric superiority and the greater organizational level of the expanding units, that could have been reflected in a greater military force, it can be supposed that small groups of hunters-gatherers living in the peripheral belt (if they had not been totally exterminated) could have been forced to take refuge beyond the limit of the main distribution area, that is inside one or more environmental discontinuities. The permanence in the peripheral belt of the population units coming from high seasonal productivity sites would have been temporary, hence theoretically the individuals forced beyond the environmental discontinuity line would have had the opportunity of going back to the previously occupied territories, after escaping the dangers.

However, it must be considered that, even though for just a short period, the high density of the distribution area's peripheral belt would have determined the depletion of food resources, and consequently it would not have been advantageous anymore to go back, for the population units that had been previously distributed in that zone; they would have therefore been induced to stay inside the new environment.

Nonetheless, during the advancement phase of the expanding population units, many other animal species would have been forced to take refuge inside such environment to avoid being hunted. It can therefore be hypothesized that the carrying capacity could have slightly increased in that area, allowing the refugee groups to survive without particular difficulties during the initial critical moment of the colonization of the new environment. Afterwards, these groups could have adapted to the new climatic and productive conditions thanks to their characteristics, and could have spread inside the new system. In the new environment (that could have either been a forest area, or a desert, or more generally an area with very low carrying capacity), these groups would have been forced to adopt a more marked *K* strategy and a stronger nomadic lifestyle than before; we find these characteristics in the majority of the most recent nomadic hunters-gatherers.

28. APPLICATION AND LIMITS OF THE MODEL

Finally, let us see how the above discussed expansion model can be applied to the global diffusion process of *Homo sapiens*, and also what its limits are. First of all, it has to be stated beforehand that what we interpret and perceive as a global process is the result of a series of local events, separated in space and time, that have been concerning single population units or a few units at the most, closely linked by socio-economical relations.

Affirming that human populations occupied at first the most favourable environments and later less favourable environments from a climatic and/or productive point of view can be adequate to interpret the process in general terms. In fact, our species firstly dispersed at low latitudes (Intermediate Tropical Belt) and later at high latitudes, in quite cold environments, following a latitudinal climatic gradient (South-North).

On the other hand, it is clear how this does not mean that men started to colonize more "extreme" environments only after all the favourable environments had been occupied. It must not be forgotten in fact that, at the same latitude, the altitudinal gradient (Low-High) and the different physiographic and/or ecological conditions that can be found along longitudinal axes (East-West) must be locally recognized.

At a local level, until the given environmental anisotropy belts maintain their efficacy precluding the way towards new favourable territories, some population units can occupy marginal zones of the distribution area for a relatively long time. Later, according to our model, after an expansion phase from the central territories of the distribution area, they can colonize zones of environmental discontinuity. This event may have occurred in a very precocious phase of the planet's colonization process, and it may have been repeated many times at a local level as the process of global expansion was taking place.

It is nevertheless important to highlight that it is not always necessary to hypothesize a massive expansion from the internal territories to justify the colonization of new environments by the units that are distributed in the distribution area's peripheral belt. If the stasis phase of the distribution area of a population was very long, that is if one or more barriers represented an insurmountable obstacle for a long time, and in the case of rapid and temporary increase of population, the need for new spaces could lead some population units (not necessarily distributed in the distribution area's peripheral belt) to colonize previously unoccupied fractions of the distribution area's environmental mosaic.

Another important point to emphasize concerns the effect that the invasion by population units during an expansion phase would have on already occupied favourable areas. In this case, some groups could be forced by the expanding units coming from external areas to take refuge inside different environmental systems. The individuals that used to occupy the most favourable areas would have to adapt to new climatic and productive conditions and undergo a socio-cultural "*conversion*" (we prefer this term to "*regression*"). The fact that these individuals had originally come from complex societies, and therefore had a relatively high knowledge (also technological), could favour their adaptative process to the new environment.

For what concerns this, it is appropriate to refer to the work of Bailey et Al. (1989), which considers that men's life in the tropical forest would require a complex technology. They affirm that human adaptability does not include the ability of surviving in the tropical forest for long periods of time, at least until ways of modifying the edible plants' density and distribution are developed, through their domestication and thanks to the temporary use of small land parcels, cleared of spontaneous vegetation with the use of fire (itinerant agriculture). In addition, archaeological studies in Western Africa (Mercader and Martí, 1999a, b; 2000; Mercader et Al., 2000) document the occupation of tropical forest areas between 34,000 and 30,000 years ago.

Finally, it must also be stressed that it is not always necessary to postulate the presence of population units in peripheral zones of the distribution area: the zones with high carrying capacity in a given area could be sufficiently extended as to guarantee favourable subsistence conditions to all the distributing population units. In such a case, a possible expansion of the central fractions would not determine a movement of colonization of different environmental situations, but purely of dispersion towards new favourable areas.

It is therefore evident that the dynamics of the expansion of the *Homo sapiens* populations are rather complex, and that no single model can explain all the processes that led to the colonization of new environments.

At this stage, we wish to briefly summarize the main aspects of the expansion process: first of all, it has been overall very rapid, as less than 50,000 years have passed from the first successful great migration outside the African continent to the complete colonization of the planet. However, as it can be seen from the studies on NRY (Underhill et Al., 2001), this process has neither been linear nor gradual, but more or less discontinuous, with alternating expansion and stasis or contraction phases. It can generally be said that after its appearance and first expansion in Africa, the distribution area of our species has been relatively static for at least 60,000 years – if we date the appearance of the *Homo sapiens* species *sensu stricto* back to around 130,000 years ago. To this, a rapid phase of expansion towards south-western Asia and Japan followed, and later to Australia (at least 60,000 years ago).

We believe that the populations involved in this expansion would have simply dispersed along the Indian ocean coast following similar ecological directrices, until they stopped in correspondence to the Wallace Line. Further increases in these populations' density would have later determined their colonization of the most internal regions of the Asian continent, and also, after the suitable navigation techniques were developed, a colonization of Australia through successive waves. Later, a second expansion phase would have started from Africa towards the Near East and central Asia (45,000-30,000 years ago), and from here to northern Asia and Europe (30,000-20,000 years ago).

Some authors write that the populations from this new migratory wave were more socially complex than those who used to live in Africa a few thousand years before, and also than those that had first left the African continent along the Indian ocean coast. Clearly, we do not have any elements to corroborate or confute this hypothesis. The only consideration we can make is that, based on the gathered data, these populations would have dispersed in a greater way than the others, and that probably their diet would have been more dependent on big terrestrial mammals, considering their main dispersal on the internal territories of the Eurasian continent. Thus, their social organization would have possibly been more articulated, compared to that of the first African populations who, as we saw, would have prevalently used marine resources. At this stage, the distribution area of our species, that used to include a great part of the Old World and of Australia, underwent a contraction, mainly in Eurasia; later, the colonization of northern America followed (at least 20,000-15,000 years ago), and then of the whole American continent (around 12,000 years ago).

It is also highly probable that the colonization of America happened in several times and in different periods. It also seems that the Siberian populations that colonized the American continent first occupied savanna or prairie areas, with a great availability of ungulate mammals, whereas forest and desert environments do not seem to have been colonized during Pleistocene (Hammond, 1980).

29. THE ORIGINS OF AGRICULTURE

It is quite evident that once the colonization of the planet was completed, some human populations would have not been able to only count on emigration to solve their problem of acquisition of new resources. Although the total number of individuals was relatively small at that time, the available space for colonization (mostly the optimal space) was already almost all finished (Cohen, 1977; Cavalli-Sforza, Menozzi and Piazza, 1997:201). After a long period of resources exploitation through hunting and gathering, and after some less favourable environments had already been colonized, men were forced to increase the ecosystem's yield per surface unit in the most densely populated areas. That is how some population units (we believe Class A population units) would have modified their productive strategy, and started practicing agriculture and farming.

In spite of needing a greater energetic investment, these new strategies proved to be good adaptations, and this determined a strong demographic growth in the areas where they had been adopted. Therefore, new expansion phases started from at least 10,000 years ago, that in many cases forced population units to take refuge in isolated zones with a low carrying capacity (Cavalli-Sforza, Menozzi and Piazza, 1997; Underhill et Al., 2001).

Agriculture and farming started autonomously in a few areas of the planet and with very different times, and they spread from their original nuclei in two ways, as the neighbouring people learnt the new techniques, and/or were invaded by the early farmers (*demic expansions*). These events too occurred at rather different times in the various parts of the world.

With certainty and in detail, only five areas of the planet have been identified where the domestication of autochthonous plants and animals was spontaneous: the Near East (the famous Fertile Crescent), China, Mesoamerica (central and southern Mexico, and the surrounding areas), the Andes and (maybe) the adjacent Amazon basin, and the eastern part of today's United States. These macro-areas can include many more or less independent production centres, like the Yangtze and the Yellow River valleys, respectively in the south and north of present China, while for the other possible candidates (Sahel, western equatorial Africa, Ethiopia and New Guinea) there are many uncertainties (Diamond, 1997).

Thus, agriculture caused the effect of stressing the *r* strategy of some population units; it also favoured a more sedentary lifestyle (the first great permanent villages appeared in some areas), and it determined a significant demographic growth thanks to a greater resources surplus, guaranteed by the direct management of production. This in turn caused new migratory waves towards fertile territories, as we have seen, but later also the intensification of the agricultural production (Boserup, 1995), obtained with a large-scale development of irrigation techniques (thus, the first historical "civilizations" were born).

For what concerns Class A population units, it is therefore possible to hypothesize a general cyclical model (Fig. 10) that forecasts 3 possible strategies (not necessarily self-excluding), according to which such units, facing a population density increase in their distribution area, could have:

1) **Emigrated**

2) **Practiced new forms of cooperation and trade** (which after the establishment of the agricultural economy would have been more and more intense)

3) **Elaborated new productive strategies (**reaching the capitalistic-industrial production mode)

The development of the material culture would have therefore been determined by the search for new productive strategies, directed to intensify production. This would have led to a further rise of population (*positive feedback*), and consequently to the repetition of this cycle for successive generations.

Commerce and cooperation with other population units too would have led to a density increase, as both these activities favour the intensification of production[24]. From this scheme it can be deduced that the material culture's development, and thus the scientific and technological developments, would have been linked to reasons of historical contingency and of necessity, and not to supposed cultural superiorities of some populations if compared to others.

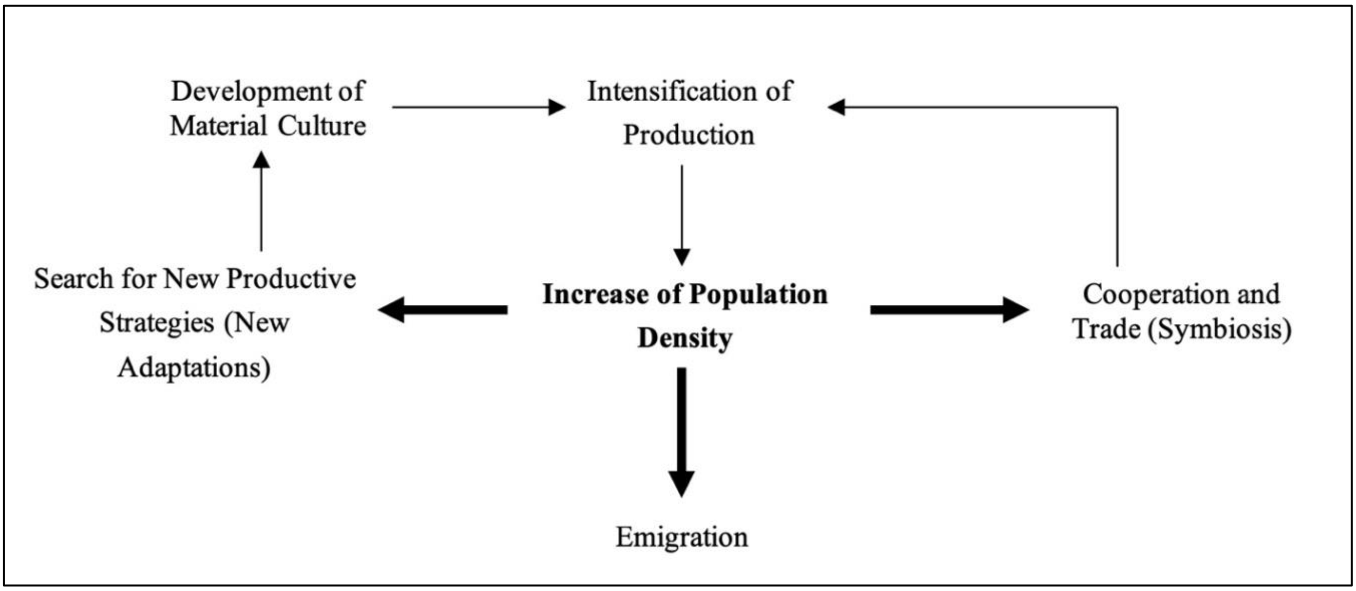

Fig. 10. General effects of increasing population density on the social, economic and cultural evolution of Homo sapiens

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[24] The scheme that is hereby proposed is rather simplified, and many more factors should be considered: above all, the competition with other population units that would promote population growth (the bigger the number of individuals, the more the possibilities of defeating the enemy population units) on one side, and on the other, the search for more and more sophisticated military technologies, which have historically had very important exactive effects on the development of material culture.

CONCLUSIONS

A life-long study would not be enough to eventually reach completely coherent results about such complex issues as the topics discussed in this work. Nevertheless, some conclusive reflections and a synthesis of our thought need to be made.

First of all, we would like to highlight a specific aspect that seems to find confirmation in our study, that is the importance that economic organization acquires in the analysis of all social formations, thus constituting a fundamental element. It is therefore possible to hypothesize a general model (Fig. 11) involving a synergy of the way of using and producing natural resources (**the economy**), of the way of socially organizing in order to do so (**politics**), and of the abilities, the beliefs and the common uses and interests within a society that make such organization possible and legitimize it (**culture),** in the evolution of human populations.

As it has been affirmed, with the term economy we intend the totality of the reproductive, alimentary, commercial and military strategies that are adopted by a human population in order to optimize the use of the resources of their occupied area, or in "politically" near areas with which the unit commercially trades resources. Hence, the production mode ultimately describes the ecological characteristics of a human population. The adoption of a specific production mode requires labour organization and roles inside the social group. This organization will be as efficient as the level of **cohesion** of the population unit. Generally, as long as the aggregation forces inside a society prevail over the disaggregation forces, that society will enjoy a relative welfare and ideal conditions for its growth, and so its production mode will be consolidated. This presupposes that, from a cultural standpoint, the majority of the individuals in a population unit shares ideas, knowledge, values, beliefs and interests that allow and legitimize the instauration of precise relations of production and cooperation. In other words, there must be a certain degree of ***ideological cohesion*** inside a population unit, functional to the affirmation of specific ***economic politics***.

This frame of ideas, that we deduced from a mostly ecological and biogeographical analysis, is not dissimilar to what the German philosopher and economist Karl Marx (1820-1883) proposed.

According to Marx, the forces regulating the dynamics of the history of human societies must be searched in the production ways and organization, that is in the ways in which men produce the elements of their material life (***historical materialism***). For Marx, this is the starting point for understanding the structure of social life: everything else (juridical norms, organization of the state, culture, religion) represents the superstructure of the economic conditions of production and exchange:

"*In the social production of their existence, men inevitably enter into definite relations, which are independent of their will, namely relations of production appropriate to a given stage in the development of their material forces of production. The totality of these relations of production constitutes the economic structure of society* […] *to which correspond definite forms of social consciousness. The mode of production of material life conditions the general process of social, political and intellectual life. It is not the consciousness of men that determines their existence, but their social existence that determines their consciousness*. [...] *The changes in the economic foundation lead sooner or later to the transformation of the whole immense superstructure. In studying such transformations it is always necessary to distinguish between the material transformation of the economic conditions of production, which can be determined with the precision of natural science, and the legal, political, religious, artistic or philosophic – in short, ideological forms in which men become conscious of this conflict and fight it out*." (Marx, 1859, 1977, online edition).

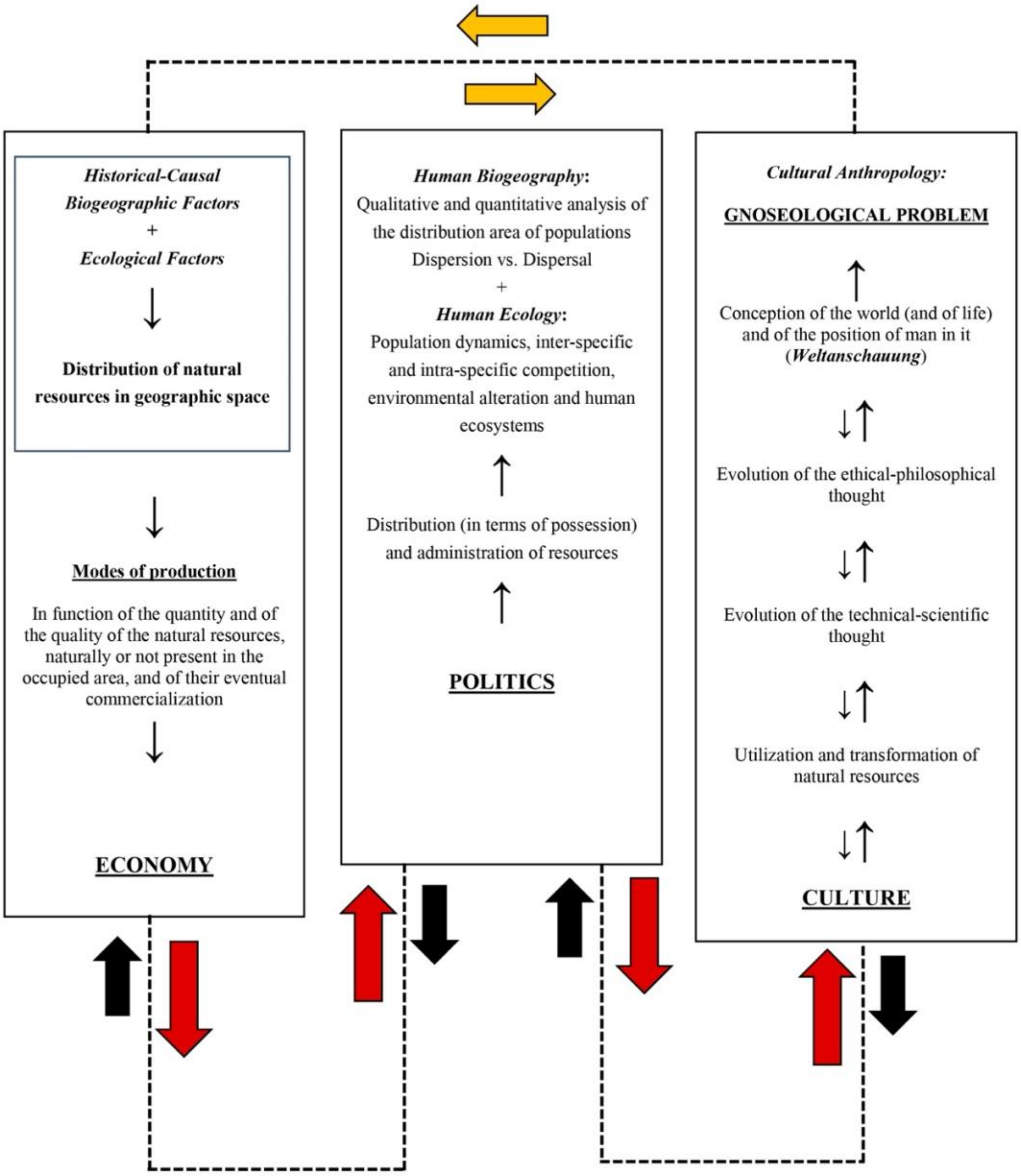

Fig. 11. Causal relationships between Economy, Politics and Culture

From an historical standpoint, we consider that four general production modes are significant, which have characterized the evolution of human populations:

a) the production mode based on hunting and gathering
b) the production mode based on agriculture and farming
c) the big landowner-feudal production mode
d) the capitalistic-industrial production mode.

However, the majority of researchers agrees on the fact that the change from the hunting and gathering economy to the agriculture and farming economy has been the most important transformation for the evolution of human societies.

In our opinion, the substantial difference between these two economies is that with hunting and gathering the ecosystems' natural production is used, and its real yield can be increased producing more and more efficient techniques and tools, whereas with agriculture and farming the ecosystem's production is **managed** by men who, investing a specific aliquot of energy (also as labour force) and favourably modifying the natural environment, use the environment's **potential yield**.

In fact, in both cases men increase the carrying capacity of the environment to their own advantage, but in the hunting and gathering case there is a limit beyond which the carrying capacity cannot further be enhanced (as production quantity and time are principally determined by processes that are independent of human activity). On the other hand, in the case of agriculture (that from a specific moment onwards has been evolving towards an ever-increasing product yield but with the same cultivated surface, through an ever-increasing energy investment), the carrying capacity can *apparently* be enhanced without limits, so that today's (2004, editor's note) world population consists of more than 6 billion individuals.

During our research, we also observed how the hunter-gatherer population units from the Late Pleistocene had to form heterogeneous and diversified social systems, just as the environments they had occupied. Particularly, we hypothesized the existence of relatively great population units with a sufficiently complex social structure that had high growth rates (*Class A*), and of smaller population units with a less complex social structure (*Class B*). Consequently, the existence of different economy models based on hunting and gathering must be hypothesized[25].

All these reflections are in contrast with the widespread idea that the first hunting-gathering populations would have (all) been formed by a few tens of individuals, and subject to birth control mechanisms, both direct, of socio-cultural nature (infanticide, abortive practices, contraception), and indirect, of ecological and biological nature (food shortage, lower fertility of women, and high mortality, mainly among infants, due to infective illnesses) (see Hassan, 1973). These occurrences would have determined a low growth rate of the first human populations and an essentially nomadic lifestyle.

In fact, while from an ecological point of view all hunters-gatherers are generally and indiscriminately thought to have similar characteristics to those of species or populations which adopt a *K* strategy, and agricultural and animal farmers are described as *r-strategists*, from the literature data we gathered the reality seems different. It would actually seem that the Late Pleistocene hunters-gatherers (and also the recent ones) had adopted both the *K* and the *r* strategies.

In addition, it could also be hypothesized that the *r* strategy had been adopted by modern man before the *K* strategy. In any case, they would both represent strategies that human populations would have early adopted, in function of the type of occupied environment (*K-selective* or *r-selective*), and generally in function of the quantity and quality of the resources in an area and in a given moment. It could therefore be possible to distinguish between population units that have been prevalently *r-selected* and others that have been mainly *K-selected*, already in the primordial phases of the evolution of *Homo sapiens*. This would be coherent with the relatively evident fact that during the Late Pleistocene and the beginning of the Holocene, the *Homo sapiens* populations were distributed in different types of biomes, to which different ecological characteristics and social structures should have necessarily corresponded.

The *r-strategist* population units were the most successful in our species' evolutionary history. They were formed by a relatively high number of individuals, and had a more complex social structure than the *k-strategist* units as well as a higher vagility, and hence they dispersed more

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[25] Even today we cannot talk about just one economy model based on agriculture and on farming: coherently with the type of environment and of society, different rural, feudal and industrial models exist.

extensively. The *K-strategist* population units occupied more stable and more isolated environments, so their ecology and social structure did not quite vary in time.

On the other hand, the r-strategist units occupied more unstable environments where they periodically were under unbalanced conditions as the existing resources were lacking. The loss of the equilibrium would have forced the units to migrate or to modify their adaptations and their ways of using the resources towards an ever-increasing product yield per surface unit, coherently with local increases of the population density to the limit of the environment's carrying capacity (Boserup, 1965, 1981; Dumond, 1965; Cohen, 1977).

In addition, considering the high vagility of such units, they were less isolated from one another. This would have meant stronger competition, but also a greater exchange of knowledge and of information among different cultures - two factors that significantly amplified the social evolution of human populations.

Therefore, the *r-strategists* were the population units that underwent the greatest social variations in time, in the sense of an ever-increasing growth of their complexity. In fact, the great historical "civilizations" would have originated from these units, in Africa, in the Near East, in India, in China, in Mesoamerica and South America, as they were units that already possessed an r-strategy, and that, in our opinion, would have first and independently started the practice of agriculture and farming. These were adaptation that further stressed the r-strategy.

Hence, according to what has been hereby hypothesized, the *fundamental structural plans* of human societies (that can be found in all contemporary societies) would have occurred quite early in the evolutionary history of *Homo sapiens*, possibly even before its appearance. Some of these structures have remained almost identical, such as the forest hunter-gatherer societies, while others as we observed have undergone a process of *complexification*.

Also, although every human population unit has had its own evolutionary history and specific cultural characters, we think that it is possible to find one logic in our species' social evolution.

In fact, we believe that it can be theoretically affirmed that:

1) human population units, distributed among similar biomes, are characterized by a similar social structure and organization.

2) cultural diversity, as regards uses, customs, traditions, beliefs, taboos, and also technological potentialities, is correlated to the biota's specificities and to the abiotic conditions of the occupied area.

Under the same ecological conditions, therefore, human population units would develop similar adaptations and productive strategies, which would vary – more formally than substantially – in function of the geological and biogeographical history that characterized the area where they are distributed. To use a metaphor, also employed to explain the concepts of biome and biota, we could say that under similar ecological conditions, *the "play" remains the same* (the basic social structure), *although the "actors" vary* (the cultural forms expressed by men).

For example, the State, intended as a social structure, has originated several times and independently in various regions of the planet, but in spite of its different and variegated forms of past and present manifestations, its structuring logic is always the same: centralized power, hierarchical organization of classes, marked labour division, social inequality, cities as main centres of knowledge and goods exchange, laws and "guide values" to be observed. On the other hand, in ecological terms the birth of the State reflects the adoption by some population units of productive strategies which are based on great-scale agriculture and farming (a phenomenon that occurred in different regions of the plane in different times).

This way of interpreting the social evolution of the human population units would be of great use for analyzing the cultural diversity that has always characterized the history of humanity, at least until a few centuries ago, and the socio-evolutionary convergence characters that can be found in societies that have developed separately and independently in space and time.

BIBLIOGRAPHICAL REFERENCES

BAILEY R.C., HEAD G., JENIKE M., OWENS B., RECHTMEN R., ZECHANTER E. (1989) *Hunting and Gathering in Tropical Rainforests: Is It Possible?* American Anthropologist, 91: 59-82.

BAR-YOSEF O. (1998) *On the Nature of Transitions: The Middle to Upper Palaeolithic and the Neolithic Revolution*. Cambridge Archaeol. J., 8: 141-163.

BINFORD L.R. (1968) *Post-Pleistocene Adaptations*. In BINFORD L.R. e BINFORD S. R. (Eds) *New Perspectives in Archaeology*. Chicago: Aldine.

BINFORD L.R. (1985) *Human Ancestor: Changing Views of their Behavior*. J. Anthrop. Archaeol., 4: 292-327.

BINFORD L.R. (1989) *Isolating the Transition to Cultural Adaptations: An Organizational Approach*. In TRINKAUS E. (Ed.) *Emergence of Modern Humans: Biocultural Adaptations in the Late Pleistocene*. Cambridge, Ma.: Cambridge Univ. Press.

BIRDSELL J.B. (1966) *Some Predictions for the Pleistocene Based Upon Equilibrium Systems Among Recent Hunters*. In LEE R.B. e DEVORE I. (1968) (Eds.) *Man the Hunter.* Chicago: Aldline.

BOSERUP E. (1965) *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure*. Chicago: Aldine.

BOSERUP E. (1981) *Population and Technological Change: A Study of Long-term Trends*. Aldine. Chicago

BROADHURST C.L., CUNNANE S.C., CRAWFORD M.A. (1998) *Rift Valley Lake Fish and Shellfish provided Brain Specific Nutrition for Early* Homo. British Journal of Nutrition, 79: 3-21.

BUTZER K.W. (1964): *Environment and Archaeology: An Introduction to Pleistocene Geography*. Chicago: Aldine.

CAVALLI-SFORZA L.L., MENOZZI P., PIAZZA A. (1997) *Storia e Geografia dei Geni Umani*. Milano: Adelphi.

CHAMBERLAIN J.G. (1996) *The Possible Role of Long-Chain Omega-3 Fatty Acids in Human Brain Phylogeny*. Perspectives in Biology and Medicine, 39: 436-445.

CLARK J. D. (1980): *Early Human Occupation of African Savanna Environments*. In HARRIS D.R. (Eds.) Human Ecology in Savanna Environments. London: Academic Press.

CLARK J.G. (1968) *World Prehistory: A New Outline*. Cambridge, Ma.: Cambridge Univ. Press.

CODY M.L. (1966) *A General Theory of Clutch Size*. Evolution, 20: 174-84.

COHEN M.N. (1977) *The Food Crisis in Prehistory: Overpopulation and the Origins of Agriculture*. New Haven: Yale Univ. Press.

CRAWFORD M.A. (1992) *The Role of Dietary Fatty Acids in Biology: Their Place in the Evolution of the Human Brain*. Nutrition Reviews, 50: 3-11.

CRAWFORD M.A., BLOOM M., BROADHURST C.L., SCHMIDT W.F., CUNNANE S.C., GEHBRESMESKEL K., LINSEISEN F., LLOYDSMITH J., PARKINGTON J. (1999) *Evidence for the Unique Function of Docasahexaenoic Acid during the Evolution of the Modern Human Brain*. Lipids, 34**:** S39-S47.

CROIZAT L. (1958) *Panbiogeography, or an Introductory Synthesis of Zoogeography, Phytogeography, and Geology; with Notes on Evolution, Ecology, Anthropology etc*. 3 Vols. Caracas: L. Croizat.

CROIZAT L. (1962) *Space, Time, Form: The Biological Synthesis*. Caracas: L. Croizat.

DARLINGTON P.J. (1943) *Carabidae of Mountains and Islands: Data on the Evolution of Isolated Faunas, and on Atrophy of Wings*. Ecol. Mon., 13: 37-61.

DIAMOND J. (1992) *The Third Chimpanzee*. New York: Harper Collins

DIAMOND J. (1997) *Guns, Germs, and Steel. The Fates of Human Societies*. New York-London : W.W. Norton & Co.

DOBZHANSKY T. (1950) *Evolution in the Tropics*. Amer. Sci., 38: 209-21

DOBZHANSKY T. (1966) *L'Homme en Évolution*. Paris: Flammarion

DUMOND D.E. (1965) *Population Growth and Cultural Change. Southwestern Journal of Anthropology*, 21: 302-324

DYSON-HUDSON R., SMITH E.A. (1978) *Human Territoriality: An Ecological Reassessment*. American Anthropologist, 80: 21-41

ELDREDGE N., GOULD S.J. (1972) *Punctuated Equilibria: An Alternative to Phyletic Gradualism*. In SCHOPF T.J.M. (Ed.) *Models in Palaeobiology*.

ERWIN T. (1981) *Taxon pulses, vicariance, and dispersal: an evolutionary synthesis*. In NELSON G. e

ROSEN D.E. (Eds.) *Vicariance Biogeography: A Critique*.

FLANNERY K.V. (1968) *Origins and Ecological Effects of Early Domestication in Iran and the Near East*. In UCKO P., DIMBLEBY G.W. (Eds.) *The Domestication and Exploitation of Plants and Animals*. Chicago: Aldine

FOLEY R.A. (1995) *Humans before Humanity*. Oxford: Blackwell

GADGIL M., SOLBRIG T. (1972) *The Concept of r- and K-selection: Evidence from Wild Flowers and some Theoretical Considerations*. Amer. Nat., 106: 14-31

GOODMAN M., CZELUSNIAK J., PAGE S., MEIRELES C.M. (2001) *Where DNA sequences place Homo sapiens in a phylogenetic classification of Primates*. In TOBIAS P.V., RAATH M.A., MOGGI-CECCHI J., DOYLE G.A. (Eds.) *Humanity from African naissance to coming millennia*. Florence: Florence Univ. Press & Witwatersrand Univ. Press

GROSSE E. (1896) *Die Formen der Familie und die Formen der Wirtschaft*. Leipzig & Freiburg: Mohr

HAMMOND N. (1980) *Prehistoric Human Utilization of the Savanna Environments of Middle and South America*. In HARRIS D.R. (Ed.) Human Ecology in Savanna Environments. London: Academic Press

HARRIS D.R. (1980) (a cura di) *Human Ecology in Savanna Environments*. London: Academic Press

HARRIS D.R. (1980) *Commentary: Human Occupation and Exploitation of Savanna Environments*. In HARRIS D.R. (Ed.) Human Ecology in Savanna Environments. London: Academic Press.

HASSAN F. (1973) *On Mechanisms of Population Growth During the Neolithic*. Current Anthropology, 14: 535-542

HOLE F., FLANNERY K.V. (1967) *The Prehistory of South-Western Iran: A preliminary Report*. Proc. Prehist. Soc., 33: 147-206.

HOWELLS W.W. (1976) *Explaining Modern Man: Evolutionists vs. Migrationists*. Journal of Human Evolution, 5: 477-495.

KLEIN R.G. (1989) *Biological and Behavioral Perspectives on Modern Human Origins in Southern Africa*. In Mellars e Stringer (a cura di) *The Human Revolution: Behavioral and Biological Perspectives on the Origins of Modern Humans*. Edinburgh: Edinburgh Univ. Press.

KLEIN R.G. (1999) *The Human Career: Human Biological and Cultural Origins*. (2nd edition). Chicago: Chicago Univ. Press.

KLEIN R.G. (2000) *Archaeology and the Evolution of Human Behavior*. Evol. Anthrop., 9: 17-36.

KUHN S.T. (1962) *The Structure of Scientific Revolution*. Chicago: Chicago Univ. Press.

LAHR M.M., FOLEY R. (1994) *Multiple Dispersals and Modern Human Origins*. Evolutionary Anthropology, 3: 48-60.

LAHR M.M., FOLEY R. (1998) *Towards a Theory of Modern Human Origins: Geography, Demography and Diversity in Recent Human Evolution*. Yrbk. of Phys. Anthropol., 41: 137-176.

LIEBERMAN D.E., SHEA J.J. (1994) *Behavioral Differences between Archaic and Modern Humans in the Levantine Mousterian*. Am. Anthrop., 96: 300-332.

MACARTHUR R.H. (1962) *Some Generalized Theorems of Natural Selection.* Proc. Nat. Acad. Sci. USA, 48: 1893-1897.

MACARTHUR R.H. (1972) *Geographical Ecology*. New York: Harper & Row.

MACARTHUR R.H., WILSON E.O. (1967) *The Theory of Island Biogeography*. Princeton: Princeton Univ. Press.

MACBREARTY S., BROOKS A.S. (2000) *The Revolution that wasn't: A New Interpretation of the Origin of Modern Human Behavior*. Journal of Human Evolution, 39: 453-563.

MARTEN G.G. (2001) *Human Ecology. Basic Concepts for Sustainable Development*. Earthscan Publications Ltd.

MASSETI M. (2002) *Uomini e (non solo) Topi. Gli Animali Domestici e la Fauna Antropocora*. Florence: Florence Univ. Press.

MARX. K [1859] *Zur Kritik der politischen Ökonomie*. (1977) A Contribution to the Critique of political economy. Moscow: Progress Publishers. Online edition, http://www.marxists.org/archive/marx/works/1859/critique-pol-economy/ (Preface).

MELLARS P.A., STRINGER C. B. (Ed.) (1989) *The Human Revolution: Behavioral and Biological Perspectives on the Origins of Modern Humans*. Edinburgh: Edinburgh Univ. Press.

MERCADER J., BROOKS A., PIPERNO D., MARTI R., HOLST I. (2000) *Ancient Foragers as Early Colonizers of Tropical Forests*. J. Hum. Evol., 38: A21-A22.

MERCADER J., MARTI R. (1999a) *Middle Stone Age Site in the Tropical Forest of Equatorial Guinea*. Nyame Akuma, 51: 14-24.

MERCADER J., MARTI R. (1999b) *Archaeology in the Tropical Forest of Banyang-Mbo, SW Cameroon*. Nyame Akuma, 52: 17-24.

MERCADER J., MARTI R. (2000) *The Middle Stone Age Occupation of Atlantic Central Africa: New evidence from Equatorial Guinea and Cameroon*. In MERCADER J. (Ed.) *Stone Age Settlement of Tropical Forests*. Cambridge: Cambridge Univ. Press.

MORIN E. (1973): *Le Paradigme Perdu: La Nature Humaine*. Paris: Edition du Seuil.

MORIN E. (1997): *La Unidualidad del Hombre*: Gazeta de Antropología, 13: 1-13.

MOSCOVICI S. (1972): *La Société Contre Nature*. Paris: UGE.

NIETZSCHE F.W. [1878] (1990) *Umano Troppo Umano. Un Libro per Spiriti Liberi*. Roma: Newton Compton.

NOBLE W., DAVIDSON I. (1991) *The Evolutionary Emergence of Modern Human Behaviour: Language and its Archaeology*. Man, 26: 223-253.

PIEVANI T. (2002) Homo sapiens *e Altre Catastrofi*. Roma: Meltemi.

RAPOPORT E.H. (1975) *Areografía: Estrategias Geográficas de las Especies*. Mexico City: F.C.E.

RAPOPORT E.H., DRAUSAL B. (1979) *Tácticos y Estrategas r, K y "SOS"*. In RABINOVICH J., HALFFTER G. (Eds.): *Tópicos de Ecología Contemporánea*. Mexico City: F.C.E.

STRINGER C. (2000) *Palaeoanthropology: Coasting Out of Africa*. Nature, 405: 24-27.

STRINGER C., ANDREWS P. (1988) *Genetic and Fossil Evidence for the Origin of Modern Humans*. Science, 239: 35-68.

SWISHER C.C. III, RINK W.J., ANTON S.C., SCHWARCZ H.P., CURTIS G., SUPRYO A., WIDIASMORO C. (1996) *Latest* Homo erectus *of Java: Potential Contemporaneity with* Homo sapiens *in Southest Asia*. Science, 274: 1870-1874.

TATTERSALL I. (1995) *The Fossil Trail: How We Know What We Think We Know About Human Evolution*. Oxford: Oxford Univ. Press.

TATTERSALL I. (1998) *Becoming Human: Evolution and Human Uniqueness*. New York: Harcourt Brace.

TESTART A. (1982) *The Significance of Food Storage among Hunter-Gatherers: Residence Patterns, Population Densities, and Social Inequalities*. Current Anthropology, 23: 523-537.

THOMSON R., PRITCHARD J.K., SHEN P., OEFNER P.J., FELDMAN M.W. (2000) *Recent Common Ancestry of Human Y Chromosomes: Evidence from Dna Sequence Data*. Proc. Natl. Acad. Sci., 97: 7360-7365.

THORNE A.G., GRÜN R., MORTIMER B., SPOONER N., SIMPSON J., MCCULLOCH M., TAYLOR L., CURNOE D. (1999) *Australia's Oldest Human Remains: Age of the Lake Mungo 3 Skeleton*. J. Hum. Evol., 36: 591-612.

THORNE A.G., WOLPOFF M.H. (1992) *Un'Evoluzione Multiregionale*. Le Scienze, 286: 22-27.

UNDERHILL P.A., PASSARINO G., LIN A.A., SHEN P., MIRAZÓN LAHR M., FOLEY R.A., OEFNER P.J., CAVALLI-SFORZA L.L. (2001) *The Phylogeography of Y Chromosome Binary Haplotypes and the Origins of Modern Human Populations*. Ann. Hum. Genet., 65: 43-62.

VANDER WALL S.B. (1990) *Food Hoarding in Animals*. Chicago: University of Chicago Press.

VERNADSKIJ V.I. (1926) *Biosfera*. Leningrad: Nauchnoe khimiko-technicheskoye izdatel'stvo.

VERNADSKIJ V.I. (1945) The Biosphere and the Noösphere. American Scientist, 33: 1-12.

VERNADSKIJ V.I. (1999) *La Biosfera e la Noosfera*. Palermo: Sellerio.

WALTER R.C., BUFFLER R.T., BRUGGEMANN J.H., GUILLAUME M.M., BERHE S.M., NEGASSI B., LIBSEKAL Y., CHENG H., VON COSEL R., NERAUDEAU D., GAGNON M. (2000) *Early Human Occupation of the Red Sea Coast of Eritrea During the Last Interglacial*. Nature, 405: 65-69.

WEIDENREICH F. (1946) *Apes, Giants and Man*. Chicago: University of Chicago Press.

WILSON E.O. (1961) *The Nature of the Taxon Cycle in the Melanesian Ant Fauna*. Am. Nat., 95.

WYNNE-EDWARDS C.V. (1962) *Animal Dispersion in Relation to Social Behaviour*. Edinburgh: Oliver and Boyd

ZUNINO M. (1991) *Food Relocation Behaviour: A Multivalent Strategy in Coleoptera*. In ZUNINO M. *et al.* (Eds.) Advances in Coleopterology: 297-314.

ZUNINO M. (1999) *A New Concept of Theoretical Biogeography: the "Nemophoront"*. In SOBTI K., YADAV J. (Eds.) *Some Aspects of the Insight of Insects Biology*. Delhi: Narendra Publ.

ZUNINO M. (2000) *El Concepto de Área de Distribución: Algunas Reflexiones Teóricas*. In MARTÍN PIERA F., MORRONE J.J., MELIC A. (Eds.) *Hacia un*

Proyecto CyTED para el Inventario Y Estimación de la Diversidad Entomologica en Iberoamerica. PriBES-2000, Monografías Tercer Milenio 1. Zaragoza: Sociedad Entómologica Aragonesa.

ZUNINO M. (2003) *Inquinamento Biogeografico e Gestione del Paesaggio: Materiali per una Visione di Sintesi*. Atti dell' "Italian-Russian Student Forum" Palermo, 23-26 Luglio 2003.

ZUNINO M., ZULLINI A. (2004) *Biogeografía. La Dimensione Spaziale dell'Evoluzione*. (2nd edition). Milan: Casa Editrice Ambrosiana