

Micro-Evolutive Processes as seen from Biological Anthropology: the Impact of Cultural factors

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Demography, biological anthropology and population genetics share in their focus on changes in human populations (Adams *et al.*, 1990). Despite their common theme, they approach the problems differently: demography describes the actual state of a population, population genetics scan modifications of the genetic pool while anthropology aims at tracing the hominids' biological and cultural history and assessing their consequences on the evolution of the same.

Adaptation can be described as the comprehensive organism/environment relations which enable a biological being to live and breed in a given place. This adaptation is not performed at a whole population level: it results from an evolutionary process calling for natural selection, which is not inevitably a process of adaptation – generative –. The results are gathered through genealogical surveys. The possibility of adaptation depends on at least one individual's genes being favourable to the modifications the environment can be subjected to. Theoretically, according to the Darwinian scale, after n generations, the “ adapted ” individuals only should survive, to the detriment of those deprived of this genetic factor. But it was observed that the “ maladjusted ” genes do not disappear altogether, but appear in a dwindling frequency. They constitute a “residual genetic polymorphism”, which presents a high range possibility of adaptation, should new modifications of environment conditions arise.

Darwin's evolution principle is simple. It is the differential descent (i.e. fecundity) which favours the individuals best adapted to their surroundings.

In the non-animal evolution patterns, the interface between environment, available resources , fecundity and genes seems well-known and the scheme validated.

On *Homo sapiens*, the application of animal patterns, whether regarding population genetics or species/environment within the framework of human ecology, have also yielded very good results which in turn entailed considerable progress in this field of research.

Concepts

To understand how populations evolve and change, one should integrate in the genetic transmission pattern parameters such as sociability level, size, limits or permeability between human groups. In the field of anthropology, the establishment of a population's biologic

profile entails from the start the consideration of cultural and social factors.

As regards the human species, another and uppermost factor acts along the biological one. The latter should not be considered solely in a functionalist perspective, which would reduce all human behaviour to mere environmental factors. These, indeed, are important but they lack the necessary strength to account, by themselves, for the whole process.

The concept of biological population

As seen individually, each human fits within a structure made up by his relationship to mankind: direct relationship or wider kinship, social, economic, political ties... First of all comes family as the closest connection with another being, since it is established before birth. The degree of relationship between individuals of a same population allows to outline one of its biological expressions. Anthropologically speaking a population can theoretically be governed by a so-called simple structure (known in social anthropology as “elementary structure of kinship”), meaning that the individuals are related by blood or alliance, which increases in intricacy as their identification with the group relies on geographical or professional criteria (complex kinship structure.).

For the populations geneticists, a “population” represents a whole, made up of individuals sharing a same genetic pool. To assess the genetic evolution of a population, the gap between the population surveyed is pitched against a theoretical law of the genetic stability of the pool which would pass down the generations a regular and immutable genetic heritage . It is the Hardy-Weinberg theory pattern.

The genic drift in the smaller populations

The population size factor is of importance because , as regards genetics, a set of few individuals breed in a particular way. The very fecund individuals bear a considerable genetic influence, whereas the genes of the less fecund dwindle rapidly down the generations. It is the phenomenon of genic drift, which can be traced in man from genealogical reconstructions. The farthest-known individuals in the genealogical chains are the “founders”.

They are the starting point from which one calculates the genealogical distance between two individuals or groups of individuals (meaning a genetic distance based on a genetic identity probability), as well as the probability of the origin of their genes. To wit, among a population famous with population geneticists (the Honduras Jicac Indians), founded over one century ago by five individuals, which remained isolated until recently, Mrs Chapman (1971) calculated the genes origin probability five generations down. She reached two conclusions: first, the genetic structure of the population changes in the successive generations as a direct results from fecundity and differential infant mortality ; second ,the immigration of individuals (Roberts *et al.* 1992), however slight, very strongly accelerates the population's genetic transformation.

The isolate concept

The specificity of anthropology consists in its breaking free from population genetics by showing *in situ* how human populations behave in actual life. Hence, among the applications of population genetics patterns to actual populations, the first one undoubtedly relates to the principle of time and space.

In the case of the time unit principle, one must keep in mind the dissociation between chronological and genealogical time, entailing methodological problems to compare cognate and agnatic lines.

As regards space unit, one must set forth the criteria used in the appreciation of a population's special limits, whether they be geographic or not. In deed, the boundaries between populations are often drawn by cultural factors. For instance, a commonly used reference as a marker for the genetic population, is the matrimonial area associated with the concept of endogamy. A so-called endogamous matrimonial area corresponds to a geographical zone wherein a minimum of 80 % of the marriages take place. For practical purposes, one often uses distance as a marker, and retains the individuals marrying within a zone covering at least 80% of the total number of marriages within in the area. The population is said to be "open" or "closed" as the spouse is chosen within (endogamy) or without (exogamy) the space it dwells in. The more restricted the choice area of the spouse, the more the endogamy is considered to be important, and the higher the degree of consanguinity.

The mode of gene circulation in human groups can therefore be classified according to two main patterns (Wright, 1946)

- the insular pattern among finished discontinued populations
- the neighbouring pattern among unfinished continued populations .

In the neighbouring pattern isolation results from distance: the remoter the places of birth of two individuals, the weaker the probability of their getting married. This pattern

has been proven among numerous populations (Boyce, 1967.; Yasuda, 1975 ; Imaizumi, 1986); it still allows for a few exceptions when some specific rules of alliance between groups , such as religious or social homogamy prevail . However, if Wright's isolation through distance pattern is relevant to pre-industrial rural populations, it is much less accurate//so when dealing with current populations. For the latter, owing to means of communication, distance is no longer an isolating factor; it is replaced by other (social, community-induced, religious...) factors acting as genetic-barrier holders between groups (Lewontin, 1974).

The "insular" pattern refers to the concept of isolate, defined by the Swede Wahlund (1928). It is a small population unit with very few genetic exchanges outside the group over an important number of generations. His definition of isolate was based , on the one hand on the population size, and on the other on the number of marriages between 4th degree relatives (first cousins) . Sutter and Tabah, subsequently attempted to formulate an "isolate methodology" (1957) by incorporating parameters close to the Hardy-Weinberg theory: population strength and limits, migrations, degree of fecundity and consanguinity and, eventually, choice of the spouse.

The endogamy and exogamy concepts

An anthropologist's first concern, when surveying a population, consists in assessing its genetic homogeneity as it appears in its degree of endogamy. Using this concept however, proves difficult, as the great majority of populations are, in the long run, genetically open . Marriage then appears as the main marker to apprehend the population's homogeneity or diversity.

Alliance and kinship

Marriage is a prerequisite to family. It is based on a fundamental biological datum (a man and a woman get together to breed offspring), which in turn induces biological and social kinship (parent-child or sibling relationship) . Marriage is ruled by precise social laws integrating cultural behaviours.

All human societies, without any exception, were controlled by family. It generates a multi-functional solidarity to which marriages, legacies, cults can be associated. One may ponder on the type of bonds linking humans to one another , the answer being that they are endowed with a dual nature: kinship can be consanguine or by marriage, consanguinity being relevant to blood-relationship, kinship to alliance. The latter are bonds parallel to the ones of consanguinity, which at times exclude, at times overlap each other. It behoves each society to name these multiple bonds of different nature, as they spring from blood when mother/child, or alliance when man/woman relationship is concerned.

Marriage, which braces sexual relationship and ensures the children's socialization, is a foremost social act, ruled by the

population's organization. In the societies known as "related by elementary family relationship" (because each individual stands in a position allotted to him from birth on), the individual's place within the group induces the type of his activity, his residence and the scope of the alliance he may strive for: the groups of families structure the social organization (Lévi-Strauss, 1949). Hence the marginalization or discredit falling upon spinsters and childless couples, in societies where the cult of the ancestors is very strong.

In our contemporary societies, the choice of a spouse seems to be made at random, as left to chance or life's circumstances (ballroom dancing, friends, holidays, work colleagues...)

The anthropologist Robin Fox (1967) summarized the family relationship systems as follows:

Principle 1: women bear children

Principle 2: men fecund women:

Principle 3: men hold the power

Principle 4: close relatives do not have intercourse

From these elementary principles (procreation, fecundation, implementation of authority and prevention of incest) which all correspond to obvious and necessary interactions between social and biological organizations, one can see how wide the scope is for modes of choice of the spouse. In societies based on subsistence economy, paid manpower does not exist: the family group provides and produces food. All seem to have to marry early and breed fast; but the number of their offspring is influenced by economic and cultural factors. Marriage is then a system of wife-allotment to men, most of the time overlooking any personal choice. It is centrally essential to the families, much less to the individuals, inasmuch as it brings the latter into lineages and allows alliances between lineages. As a rule, marriage is not a private matter, for the patterns that govern matrimonial alliances are founded on family constraints.

In more complex economic and social structures, societies in which some recurrent behaviours remain, such as the matrimonial choices of economically well-off men for women younger than themselves thus endowed with high reproductive potential, the patterns of marriages are more liable to involve individual choices, which integrate social homogamy or sexual attraction.

As regards the social control of sexuality, the most widely spread rule is that of repression of incest. Among the human species, siblings do not have intercourse, neither do parents with their offspring. Breaking this rule is incest. For Lévi-Strauss (1949), this very prohibition of incest is the blueprint of culture, the bearer of disruption of *nature* where instinct prevails. The complexity and universalism of incest, is indeed of great interest to anthropologists; it is by no means as simple as set forth by ethnologists and sexologists' theories (hinting that little attraction would exist between close related kin), and psychiatrists' (hinting that such attraction would on the contrary very much exist). Indeed, prohibition of incest would be pointless

unless it did exist. Besides, literature (Oedipus), history (Nero and his mother Agrippina), as well as criminology, stand witness to its reality.

Exogamy/ Endogamy

The most efficient means implemented by human groups to prevent incest is exogamy, the custom whereby one must marry outside the boundaries of one's own clan (or group). In simple-structure societies, descent is often unilinear, meaning handed down either by the men, or by the women. The group of descent linked by this principle is called a lineage. The lineages, often organized as clans, are usually exogamous (marriage among members of the same lineage is prohibited). The individual is then compelled to look for a spouse outside of the village, which creates strong bonds between clans and villages. Exogamy therefore fosters peace with the neighbours and increases the political impact of the individuals who worked out sound marriages for their offspring, all the more so if they are numerous. The running of exogamy entails both the onset of new alliances and the systematic renewal of the ones already existing.

Of course, one can come across groups that systematically reject exogamy; the best-known example being the "Arabic" marriage. The Arabic tribes have always attached the greatest importance to the principle of patrilinear descent. It is a segmentary society where each tribe considers itself as a large lineage divided into segments founded by the sons (then grandsons, etc...) of the "founder". Each section bears the name of its putative "founder". The leadership of the group lies with the paternal lineage, and when he sets up camp, the tents are pitched according to an order showing the degree of agnatic relationship between heads of families: the sons next to their fathers, the cousins further along the line... When it comes to ruling about a marriage-to-be, the decision lies with the men of the shortest lineage. The focus is on marriages within the closest family relationship, barring siblings. For instance, the patrilinear first female cousin is considered to be the preferential wife-to-be. Any prospective bridegroom must check on all the possible suitors who might enter the contest for the maiden, as their degree of closer family relationship would position them. The system strengthens the lienal cohesion. The anthropologist L. Mair (1971) sets forth that this type of marriage presents as many advantages and as much security as the exogamic system. Among the Bedouins it is more important to ensure a very strong cohesion within the group than initiate or develop alliances with other tribes.

Endogamy is a strict rule which imposes marriage within a certain group, prohibiting the search for a spouse outside of it. It does not aim at the group coherence, but at keeping the outer world at bay. Endogamy is associated with social stratification (i.e. the castes in India, where the untouchable are restricted to occupations related to stain and impurity: butchering, tanning, laundering... -sweeping. Belonging to the caste is hereditary and it is forbidden to marry without.)

Unlike endogamy which contributes to the reproduction of very compartmented groups, exogamy points at transformations within society. It is usually assessed by measuring the socio-professional and socio-cultural distance between the spouses, taking as a reference the occupation (or religious membership) of the male spouses' fathers and fathers-in-law' (Segalen, 1971) This concept is mostly operational in a society where the social strata evolve very slowly in the course of time, because in the case of a rapidly evolving society (as is the case in the industrialized societies since the mid-XIXth century), its application is hampered. The use of the concept of social homogamy has even met with strong criticism from sociologists (Singly, 1987). Indeed, to consider the individual's socio-professional status at the moment of his own or both spouses' parents' marriages prevents the integration of the husbands' social promotion potentialities and ignores society's emerging occupations. However, this "standard" remains useful when it comes to evaluate professional endogamy when social boundaries are rigid and transcend geographic endogamy (qualified medics, lawyers.....)

Eventually, it has been noticed that the law of endogamy is much more difficult to enforce than the law of exogamy: whereas the former enables the maintenance of the group's cohesion while generally bringing the individual no advantages, the latter leaves room for social promotion.

Genetic transmission: fecundity and mortality

The demographic disruption which occurred in many parts of the world at the time of "Neolithic revolution", when a hunting and gathering economy developed into pastoral and agricultural one, is deeply engraved in human history. It is the important energetic availability released by agriculture versus gathering, together with sedentarization, which led to the agricultural populations' increase in fecundity level, owing to the increase of their food resource availability, and reinforcing of sexual labour division. Other revolutions, technological, industrial, energetic....reflected on populations' degree of fecundity. Geographic and professional mobility, the parts allotted to women especially in Western societies, access to education and health, decreased fecundity and induced a steady increase of the average age at death.

Fecundity

It works within the limits of physiological factors (menarche and menopause) connected to living conditions, in particular food and stress. Menarche for instance, takes place on the average around the age of 13 in our Western societies and of 18 among the Kalahari CC! Kung (Howell, 1979 ; Bley and Boëtsch, 1999).

The age of menopause is more complex to determine, inasmuch as numerous physiological or pathological factors intervene. It usually occurs around the age of 45, leaving the female an approximate 30 years span of reproduction time.

How many children can a woman give birth to?

To determine the optimum capacity, anthropologists and demographers searched for so-called "natural"-fecundation populations, meaning using no birth control process.

A population of French Canadians -the Hutterites- presented the requested characteristics of a natural fecundity-regulated population. The average number of children born to a woman was 18.

This is a high figure, considering the reproduction rate for a balanced population of 2,1 child to one female. A higher rate induces population increase, whereas a lower rate points to the opposite. Western European populations show rates below 2,1.

In France, it was 1,66 in the years 1993-94. It rose to 1,89 in the year 2000. In Italy the fecundity rate was 1,22 in 1999, with important depressions in some regions. The city of Parma for instance, showed a synthetic fecundity rate of 0,66 child to one female (one child to three females). As a comparison, sub-Saharan Africa rates to 5,9 and 3,6 for the whole of the Maghreb countries.

The interval between menarche and the first-born: photogenetic interval

The most efficient means of fecundity control in the pre-industrial rural societies was implemented by the age of the girl's first marriage. This usually occurred very late, thus delaying the mother's age at first childbirth.

Among the rural population, the small landowners' sons had to settle on a farm and be economically self-reliant, before planning to wed. This brought their age to the early to mid-thirties. The girls entered matrimony in their mid-twenties. The time elapsed between first menstrual periods and first childbirth averaged generally ten years.

The inter-genesic interval

Yet another factor conditions female fecundity: the gap between two pregnancies. This parameter -in a population which does not resort to modern contraceptive means- bears strong influence on the couple's final descendants. On the whole, inter-genesic gaps are important among hunting and gathering populations. (>4 years) but very weak among agricultural societies. In our Western societies, the present fecundity rate, completely controlled by contraception, leaves no room for this operational criteria.

Infant mortality

Infant mortality rate can reach 250 0/00 in developing countries, which tallies with the one in the Western rural populations before the demographic transition, and dip to 10 0/00 in our highly medicalized societies. Factors involving living conditions are very influential. The high infant mortality rate and low life expectancy at birth, drove human populations to keep a high fecundity rate.

The population's rise in standard of living, improved food intake and implementation of efficient health policies, drastically cut down infant mortality rate, first in the industrialized countries, then in the rest of the world. The decrease entailed, with some time-delay, decrease in fecundity. This process is known as "demographic transition"

The study of this process shows the relation between fecundity and infant mortality from the standpoint of decreasing selective pressure. By combining infant mortality and fecundity by means of the "Index of Opportunity for Natural Selection", one can express the degree of selection among human populations. (Jorde et al., 1986). Hence, owing to fecundity no longer being hampered by infant mortality which used to bring about a certain number of disease-carrying genes, the possibility of natural selection is cut down to practically nil in our Western societies.

Conclusion: reproduction rate and evolutive dynamics

The influence of social and cultural factors appears predominant. We observe a drop of fecundity rate in industrialized societies, and postponed births (women first want to complete their education and the sexual division of labour is steadily dwindling). The populations of the other continents undergo the same process: decrease of the number of children and extended lifetime. In spite of a few ripples in fecundity spotted in Northern Europe, the evolutive trend tends towards a drop in population associated with an increase of life span, pointing at a peculiar future for our species which, in the long run, will consist of a dwindling number of individuals, most of which spared by natural selection, yet called for protracted old age.

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