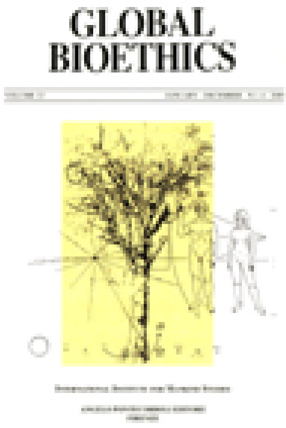

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The Carrying Capacity of the Environment as it relates to Human Consumerism

B. Chiarelli[a] & M. Annese[a]

[a] Lab. of Anthropology and Ethnology University of Florence Via del Proconsolo 12 50122 Florence - Italy Email:

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Chiarelli B.
Annese M.
Lab. of Anthropology and Ethnology
University of Florence
Via del Proconsolo 12
50122 Florence - Italy
Email: antropos@unifi.it

The Carrying Capacity of the Environment as it relates to Human Consumerism.

The authors introduce and make an attempt to describe the main problems that present and future populations of the underdeveloped world will be facing to provide enough food for themeselves.
This essay describes the anachronistic situation where underdeveloped countries grow, with big deal of economical efforts, agricultural products that eventually will be used to grow and feed cattle whose meat does constitutes the principal component of the western world diet.
Should this practice be reduced, underdeveloped countries will be able to provide food for themeselves in large quantities.
Ironically, meat diet and overfeeding, lead to a number of disease like overweight, heart attack which may lead to death.
With the abnormal and speculative increase of oil price and with the "save the world from pollution" philosophy, farmers were induced, hoping to make more profit from their work, to turn their agricultural production into product which will be used to make ecological fuel like Ethanol, retrieving, by doing so, a lot of land and products from the food market.

KEY WORDS: *Secularity, bioethical considerations*

World Human population: present and historical data

With a population of 6.7 billion units, *Homo sapiens* is now the species that exerts the highest pressure on the Planet's environment.

Since our most ancient ancestors have appeared on the Earth a long time was needed before Humankind confronted with the environment. During this period humans lived and evolved physically and culturally in balance with the availability of food provided by gathering and later also by hunting.

Pre-Palaeolithic and Palaeolithic Humankind probably never exceeded 10 million individuals. The population increasing limit was fixed by the way of life and by the kind of activity (gathering and hunting) engaged, so that vast territories were necessary for the survival of each individual. Furthermore, the mean life expectancy at birth was less than 20 years.

With the Neolithic Age (8-10 thousand years ago) the agriculture and domestication revolution, the settlement with agricultural activities and the discovery of fermentation led to a considerable increase in the world human population.

At the beginning of the Christian Era, when the basic moral concepts of the Euro-Mediterranean culture were just coded, Humankind numbered around 250 million units. At the end of the 15th century (the time of the discovery of America by Columbus), Humankind reached 470 million individuals.

However, until the sixteenth century, demographic growth was limited, with decrease due to pestilence and pandemic diseases (the North European population was reduced by a half by the Black Death which raged during the twelfth and fourteenth centuries).

In the fifteenth century 60-70 million people lived in Europe and 120-130 million people lived in China; 70 million lived in America before 1492 decreasing to 15 million only a century later due to "European colonization" that introduced new diseases for which the local population had no immunological defence.

The industrial revolution and the improved sanitary conditions, from the middle of the 18th century, gave a strong push to the growth of world population (Fig. 1).

A number of one billion inhabitants was reached around 1835 and two billions in 1925. In 1950 the world population numbered 2.5 billion. The number of 5 billions humans was reached in July 1987; in 2008 the world population numbered 6.7 billions (table 1).

The last 60 years therefore must be considered as a stage apart, not only because of the huge increase in the annual rate of population growth, but also because the increase affects specific geographical areas more than others. Population growth concerns mainly Africa, Asia and South-American, while Europe and North America tend to remain steady (table 2).

At present in most of the world, the average number of births per woman is far from the advisable value of 2.1. African women give birth to more than 6 children; in Southern Asia and Latin America the fertility rate is about 5 births per woman. Elsewhere, especially in some nation of Europe, the average number of births per woman is far below 2.1.

Table 1 – World human population form Lower Palae

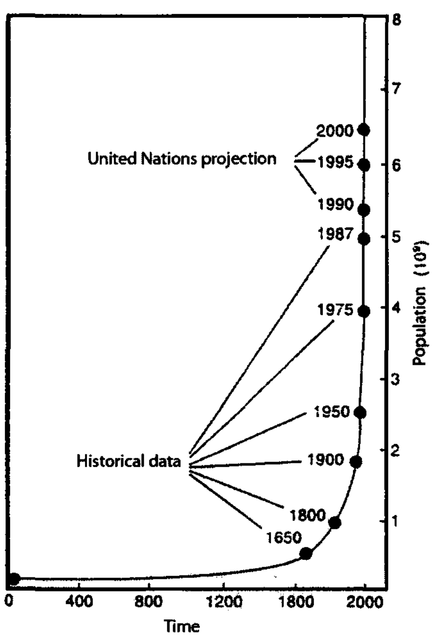

Fig. 1 World population increase. After the Christ's birth, more than fiftheen centuries were needed, (in the age of the discovery of America by Christopher Columbus) for the world population increasing to 200-300 millions, reaching the goal of half billion; it means it duplicated. During the next two centuries another half billion added and, after only one hundred years, one billion more, so that around 1930 the population reached two billion of people. In the last 70 years world population exceeded 6 billions.

WORLD POPULATION FROM THE LOW PALAEOLITHIC TO NOWADAYS		
Chronology	*World population in millions of people*	*Population increase index (year %)*
Lower Pleistocene	0.8	0.00007
Middle Pleistocene	1.2	0.0054
Upper Pleistocene	6.0	0.0100
Late Pleistocene	9.0	0.0033
Neolithic	50.0	0.085
B.C./A.D.	300.0	0.046
1300	400.0	0.022
1650	553.0	0.37
1750	800.0	0.44
1800	1000.0	0.52
1850	1300.0	0.54
1900	1700.0	0.79
1950	2500.0	1.74
1977	4300.0	2.01
2000	6000.0	
2008	6700.0	

TABLE 2 - Populations estimated between 1900 to 1990 in millions (from various sources). Note: the data for the entire USSR is included in Europe. The last column reports the ratio of 1990 to 1900 to indicate the different increase in the different continents.

Year	**1900**	**1925**	**1950**	**1970**	**1990**	**RATIO**
World	1550	1907	2516	3698	5292	3.14
Africa	120	147	222	362	642	5.35
N. Amer.	81	126	166	226	276	3.41
Lat.Amer.	63	99	166	286	448	7.11
Asia	903	1020	1380	2102	3113	3.44
Europe	422	505	574	703	788	1.87
Oceania	6	10	13	19	26	4.33

The situation will be intensified, also for the increase of life expectancy at birth, especially in those regions that most contribute to the growth of world population. According to U.N. projections till 2025, the 70% of the foreseen increase of human population will take place mainly in the South India, China, Nigeria, Pakistan, Bangladesh, Brazil, Indonesia, Ethiopia, Iran, Zaire, Mexico, Uganda, Sudan, Turkey and South Africa.

Population growth is the worst calamity that the World has now to face for its impact on the ecosystem. For years, increasingly alarming reports have been drawn up by national and international organizations involved in population studies.

Moreover the economy of various countries is seriously affected by the population trend and any environmental integrity plan will fail in the absence of demographic stability.

The population charts, moreover, show a sharp contrast between the industrialized countries, whose growth rate is low or tends to decrease, and the non-industrialized countries (where 70% of the world population lives) where the population is still growing very rapidly.

Table 2 mentions the data for the various continents in the period from 1900 to 1990. While for Europe the increase is relatively small, for the other continents, population is more than quadrupled.

Environmental integrity concept is definitely related to the problem of food and energy consumption that this huge and fast growth of human population has meant for the planet.

Present human consumerism

The growth of human population, such as the one of other animal species, depend in at first on the food availability and on its nutritional composition.

Even if, only for a preliminary presentation, we consider the amount of calories needed for individual surviving day by day we can evaluate the need at least 2000 Cal. per day, including feeding, dressing and moving, taking into account the geographical gradients which however result to be compensated by the importation and exportation of goods.

The amount of these calories required from the natural environment is obviously different if they are for one billion of people as it was for 1835 or for 6 and more billion as it is for 2008, just 170 years after (7 generation time). Something that already in 1798 Thomas Robert Malthus anticipated with his famous prediction of human population growing geometrically, while food production could increase only arithmetically.

During the last 200 years economist dismissed Malthus for overlooking technological advancement considering that food production can also increase geometrically as it depends only on lands but also on the human knowledge and the improvement of biotechnologies (seed breeding, chemical fertilizer, irrigation, mechanization etc.).

Food need can be grossly subdivided into cereals, meet, vegetable and fruit products apart for drinkable water. It can be evaluated that a mean need of calories for food intake in mankind is 1600 calories per day per person.

In the present note we consider only the cereal need which we evaluate to be around 1200 per day.

A first observation from the FAO data shows that the cereal world production from 1903 to 1985 increased for 5 times from 1066M to 5100 M. approximately in parallel with the increase of human population. The increase of the grain production is only in part due to better technologies being instead in large amount due to the extension of the areas used for grain dissemination with the destruction of the natural environment as it happened during the Roman empire with Sicily which took the name of Trinacria just from the cultivation of *Triticum* after the destruction of all the local forest.

The FAO informed also that the cereal production in 2007 was of 1.055 MM tons of whom 620 were of grain, 420 of rice and only 15 of maize.

The 2006 grain productivity is also geographically different in the five continents being of 500 million ton in Europe, 500 in America, 450 in Asia and only 100 for Africa and Australia.

The cereal price shows also a great variability with a high increase for rice price in 2008 (as shown in fig 2 and Table 3).

If these are some of the data related to the regional disequilibrium of cereal consumerism which should have an international centralized control, mainly done by the FAO, greater, and more difficult to control, is the disequilibrium in relation to animal protein resources and the vegetable and fruit need in the different population.

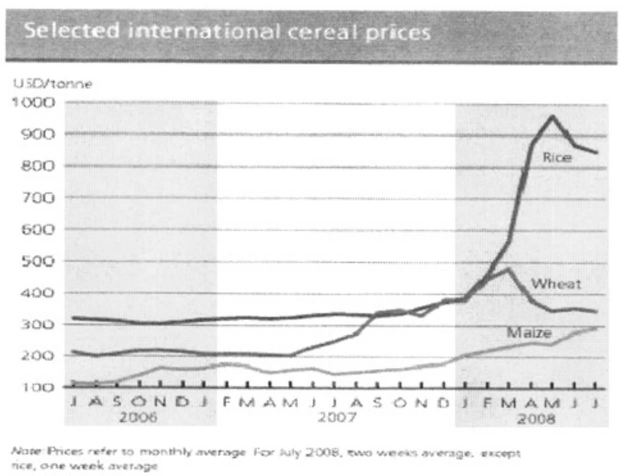

Fig. 1 – Cereal price increase in 2008 (from FAO).

TABLE 3 - Food Price Index

	Food Price Index [1]	Meat [2]	Dairy [3]	Cereals [4]	Oils and Fats [5]	Sugar [6]
2000	92	100	106	85	72	105
2001	94	100	117	87	72	111
2002	93	96	86	95	91	88
2003	102	105	105	99	105	91
2004	114	118	130	108	117	92
2005	117	121	145	105	109	127
2006	127	115	138	123	117	190
2007	156	121	247	169	174	129
2007 June	150	120	252	156	170	119
July	155	120	277	157	175	131
August	161	123	287	168	181	126
September	170	124	290	192	190	125
October	174	122	297	198	202	128
November	180	126	302	200	221	130
December	186	123	295	220	226	137
2008 January	196	126	281	236	250	154
February	215	128	278	279	273	173
March	218	132	276	278	285	169
April	215	132	266	279	276	161
May	216	141	265	271	280	155
June	216	135	263	274	292	156

[1] **Food Price Index:** Consists of the average of 6 commodity group price indices mentioned above weighted with the average export shares of each of the groups for 1998-2000: in total 55 commodity quotations considered by FAO Commodity Specialists as representing the international prices of the food commodities noted are included in the overall index.[2] **Meat Price Index:** Consists of 3 poultry meat product quotations (the average weighted by assumed fixed trade weights), 4 bovine meat product quotations (average weighted by assumed fixed trade weights), 3 pig meat product quotations (average weighted by assumed

Animal protein can be obtained by hunting or animal breeding. Hunting resources however are progressively reduced because of the reduction of wild territories occupied by cereal cultivation and many animal species, which only few decades ago were good resources for protein food in Africa or in northern regions (Siberian and Eskimo populations), that are now in the list of endangered species.

The animal breeding, on the other side, needs larger territories for producing grass for feeding. The devastating situation of many forest regions in South America is well known: one of the reasons is the cattle-breeding for producing meat for the international market.

The solution for the protein need for food use is foreseen in the increase of animal protein quality by selection and now also by cloning techniques or even by producing beefsteak through tissue culture techniques or by bacterial growing.

Vegetable and fruit production are controlled by climate conditions and by human ingeniousness and sometimes their cost in the market is expensive because of the high cost of transportation and intermediate promotion. Sometimes these products are exchanged with technological products in the industrialized countries (unfortunately these exchanges of goods frequently involve armament or instrumentation of poor quality and low use in the recipient countries).

Which future for agriculture? ***(extracted from a document released by FAO on October 15th-2004)***

Scientists have identified about 1.4 million species of plants and animals existing so far on the Planet. This variety of life is essential to human existence. We depend on it for food, water, energy, shelter, and on numerous other purposes.

But as the Planet's human population continues to expand, this biodiversity is coming under increasing threat.

The most visible harm is caused by damage to natural habitats. Wild species become extinct when the places where they live are destroyed. Pollution, urbanization, deforestation and conversion of wetlands, force out wildlife. Mismanagement of agriculture, forestry and fisheries can further accelerate this destructive process.

This *agricultural biological diversity* consists of countless farmed plants that feed and heal people, crop varieties and aquatic species with specific nutritional characteristics, livestock species apt to harsh environment, insects that pollinate fields and micro-organisms that regenerate agricultural soils.

On the farm however biodiversity is at risk. Humankind increasingly depends on a reduced amount of agricultural biological diversity for its food supplies.

Some 10.000 years ago, Mankind began a great experiment. Using the animals and plants natural biodiversity our ancestors started harvesting wild seeds and plants and domesticating them, choosing those varieties that yielded the most food, or the best rope, or which did well even in drought years and in domesticating animals; the first farmers started eating their meat and drinking their milk, to select strains of plant and breeds of animals specifically tailored to meet specific needs.

Today, genetic diversity is essential for the continued sustainability of world agricultural production.

Currently, four plant species (wheat, maize, rice and potato) provide over half of plant based calories in the human diet, while around a dozen species of animals provide 90% of the animal protein consumed globally.

Beyond the number of species used to produce food, *genetic diversity* within species and population is crucial.

Demand from a growing, urbanized population, has encouraged many farmers to adopt uniform high-yielding types of plant or animals. When food producers abandon diversity, variety and breeds may extinguish along with specialized traits. This rapidly diminishing gene pool worries experts.

In those places where hunger is worst, farmers may be more likely to need crops that grow well in harsh climates, rather than strains that yield well under good conditions, or animals that are smaller but possess higher resistance to disease. Consumers in the developing world also benefit when they have access to a wide choice of plants and animals.

With plants, animals and their environment left intact, a range of essential services provided by nature are preserved. Livestock, fungi and micro-organism decompose organic matter, transferring nutrients to the soil. Ants and other insects control pest populations. Bees, butterflies, birds and bats pollinate fruit trees. Swamps and marshes filter out pollutants. Forest prevent flooding and reduce erosion. In the ocean, intact ecosystem helps keeping fishing populations stable and healthy, ensuring a tomorrow's catch.

For feeding growing population, agriculture must provide more food. Sustainable agriculture practices can both feed people and protect the oceans, forests, prairies and other ecosystems that harbour biological diversity.

Global efforts to conserve plants and animals in gene banks, botanical gardens and zoos are vital. But an equally important task is to maintain biodiversity on farms and in nature, where it can evolve and adapt to changing conditions or competition with other species.

Present agriculture problems

Chemicals started being used in agriculture right after the Second World War and after 1960, most of the fertilizers were of a chemical nature resulting in a 25 fold increase, in overall food production and consequently pollution This result is due to a higher absorption nitrogen and favoured the selection of productions with a higher ratio between plant mass and its food yield. The availability of food has, on the other hand, considerably increased or even doubled the world human population.

Presently, agriculture practices are not capable of increasing the field's yield to follow the population growth.

The higher ratio between the mass of the plant and the eatable part of it leaves not much room to feed domestic animals with wastes; therefore, part of the food for the animals must be taken away from the human food. As a consequence, agricultural practices has become more selective.

The recent increase of cereal prices is an index of disequilibrium. At the beginning of 2006 price of one ton of wheat was about 375 dollars; two years later in 2008 the prices were three times as much. At the same time also the price of maize practically doubled.

Besides the global increase of demand and the increase of request for beef meat for food, it has been quite relevant that the decision of the US to subsidize farmers who convert maize and other cereal cultivation into ethanol to enrich gasoline for cars it has generated and it is generating problems for countries like Africa where the availability of cereals is lower than the basic requirement for living.

This difficult situation has been already highlighted in the 80s by the *Club di Roma* leaded by Aurelio Peccei *(Campanello d'allarme per il XXI secolo 1985 Ed Bompiani*), but little relevance was given to this alert, as our politicians, as they do also today, consider research over these issues promoted by different scientists of scarce importance.

The reasons why this minimal consideration is probably associated to the short duration of their power of decisional influence, usually lower than 3 - 4 years, while these issues must cover a consideration of at least one generation (25 years).

Selected cultivation

By definition however, the growth of a variety of plants and cultivations with higher yield has shown a lower resistance to parasites: large scale introduction of non endogenous plants lead to a higher exposition to attack from parasites.

This means that higher use of pesticides have a negative impact on the environment.

In China in 1949 there were about 10.000 different variety of rice, 20 years later there were only 1000, and 300 in 1993. The same thing occurred in India which had 30.000 varieties of wheat and now has only 10 high yield varieties that covers about 90% of the cultivated Indian fields. We can go on with other examples.

A F.A.O. report claims that since agriculture was "invented" (7-8000 years ago), from the 700 species of vegetables only 30 species provide 90% of food.

The less productive species have been wiped out by selective highly productive agriculture and as a consequence in 1950 wheat production was about 1000 kilos per Ha, while twenty years later it reached 5000 kilos per Ha, and in SE Asia up to 10.000. This is how it was managed to counteract the exponential increase of the world population in the past 50 years.

However, in order to assess the productive potentiality, the concept of energy requirements must be introduced.

Energy human requirement from food

To live, humankind needs to eat; the energy unit used by dieticians use is the calorie or Kilocalorie or 4200 joule of energy which is the energy required to increase water temperature by 1 °C.

The energy required by human beings, adults and children is an average of 2000 calories per day, which results in 60% from carbohydrates, 12% from proteins and 28% from fats.

A balanced diet for a human being in one year should be approximately (kilos) 100 of milk, 150 of cereals and wheat, 250 of fruit and vegetables, 25 of meat and fish, 12.5 of oil, 2.5 of sugar and 12.5 of eggs and dry fruits.

In order to produce the above quantities of food for one-year consumption, about 3000 m^3 of cultivated fields are required.

Water is also important to help the cultivation grow. The primary source of water is rain which, however, changes into quantity according to seasons and geographical location. Artificial irrigation from water wells can double the quantity of fallen rain.

The agricultural carrying capacity of the Planet for Homo sapiens

From the above figures, it can be said that, the cultivated lands required to provide food to the population presently living on the earth should cover at least 6 billion hectares.

This surface could theoretically provide food to about 10 billion people provided that mankind is the only species to utilize the land dedicated to agriculture with an exclusive vegetarian diet and with the human population distributed in order that most people live close to cultivated areas. Since this is not the case, human population's long run sustainability on this planet goes from 2 to 4 billion, with a mean value of 3 billion that was the total population at the time of the Second World War.

On the other hand, the Planet is inhabited by millions of other living species, many such as bees and birds necessary to the pollination and production of fruits. It is estimated that only 40% of land production is utilized by human beings which brings the availability of food from agriculture sufficient to feed 6 billion people as there are now on the Planet.

However the human population is not distributed in function of cultivated areas. In Australia and Canada 20 mln people live in 9 mln km^2 which is approximately 2 5 persons per km^2. On the contrary, in the Indian subcontinent at least 1,2 billion people live in only 4 million kilometres, that is 300 people per kilometre.

Therefore, a way to sustain the present population living on the planet is an efficient recycling of agricultural waste products and preservation of most of their calorific values. In this way the need of pasture lands could be reduced with a considerable saving of land space.

Moreover since rice productivity is three times more than grain with no soil damage, more land could be dedicated to farming more rice than grain. These two solutions together can lower the *per capita* need for land space.

So, what can we do to increase human food "carrying capacity" on the planet to sustain ecosystem of the planet? Apart from limiting the population growth with the purpose to return to the population of 3 billion people who were living on the planet 50-60 years ago, what kind of possibilities do we have to increase or at least to balance again the productivity?

Summary and Conclusions

We can assume that 0.4 hectares of arable terrain are required *per capita* for a long run average diet. Further we saw how, by using the 40% of all food produced world-wide, at most 6 billion people on the planet can be sustained. But since the human population is not distributed according to arable land availability, only 3 billion people, equal to the population at the end of the Second World War and before the Green Revolution, can reasonably survive.

What will happen to the population exponentially increased during the last 50-60 years? And how will we face the forecasted demographic rise to 9-10 billion by 2050?

Apart from international organisations like FAO or United Nations, demographers, anthropologists and economists have been even more deeply taken into in consideration of the demographic future of human population and on the Planet's sustainability.

According to Jeremy Rifkin, the 2 billion people who are now nearly in starving condition could have enough cereals if these were less used in the production of meat for the few in the world who eat beef, swine and white meat.

Nowadays the inhabitants of rich countries, such as Europe, North America and Japan have a diet rich of animal proteins, especially from beef. Actually in the United States, 155 million tons of cereals, legumes and vegetal proteins, potentially usable by humans, are allocated to animal husbandry, with a production of 28 million tons of animal proteins that the average American will eat in one year.

All over the world, the need for cereals in animal husbandry increases the capitalization of the multinational companies for the request of meat from rich countries. During the last 50 years meat production increased by five fold.

At present, the million acres of land in the Third World are used only for the production of fodder assigned to livestock nutrition in Europe and the United States.

The 80% of world-wide children who are facing starvation live in countries where a food *surplus* is often produced in the form of fodder and used only by wealthy consumers. In the developing countries, from 1950 to present times, the amount of grain assigned to animal husbandry now surpasses 21% of the total production of grain. In China, from 1960 to present, the percentage of grain assigned to cattle breeding tripled (from 8% to 26%). In the same period, in Mexico the percentage grew from 5 to 45%, in Egypt from 3 to 31%, and in Thailand from 1 to 30%.

The irony in the present production system is that millions of rich consumers in industrialized countries die from diseases due to food abundance (heart attack, cancer and diabetes) and an excessive animal fat diet, while the populations of the Third World die from malnutrition because they cannot farm cereals for their own nutrition.

At present, 61% of adult Americans are overweight and 300 thousand of them prematurely die every year.

But not only Americans suffer from excessive body fat. In Europe more than half of the adult population between 35 and 65 years of age is fatter than an average weight person. In the United Kingdom 51% of the population is overweight and in Germany 50% of the population weigh more than normal.

Even in developing countries, among the high wage classes the number of obese people is rapidly increasing. W.H.O. (World Health Organization) claims that the main reason for this is the excessive high-fat food intake and the adoption of the "hamburger life style". According to W.H.O. 18% of the world-wide population is obese, much the same to undernourished people.

It is estimated that chronic starvation causes 60% of infant mortality. Many people think that eating a great amount of meat, especially from grass-fed beef, is a fundamental right of their lifestyle. The "hamburger society," which includes even those who desperately seek a meal every day, is never criticized by public opinion. Meat consumers of rich countries are not interested to know, nor do they want to know how their food habits affect the life of other human beings and the political choices of entire nations.

The need for Global Bioethics concept and a clear distinction between Ethics and Morality

A rational and naturalistic definition of ethical norms must first of all stipulate the preservation of the DNA typical of the species and the maintenance of its intra-specific variability (Fig. 2).

The applicability of ethical norms to all biological entities, whether they are species or preliminary forms of individuals (spores, gametes, embryos) or products of cloning (cuttings), derives from this bioethical principle.

Hierarchical order in the history of life and its ethical significance

1st level Haploid (n): microorganisms, gametes, spores, haplophytes

2nd level Diploid (2n): sexual reproduction (meiosis).
In this 2nd level peculiar ethical concerns must be reserved to the biological entities as:
a) cutting: they are identical copies of an original individual, as they do not have variabilities,
they are produced asexually. It regards mainly cultivated plants and lower animals, now also artificial cloning in animals and possibly man (nucleo-transfer).
b) subsidiary class of social insects: they do not transmit the DNA of the species and they do not have reproductive potentialities
c) early stages of life as embryos and seeds: they have no certitude to reach the reproductive stage.
d) final stages as they have lost reproductive potential.

3rd level Diploid Biological Entities: with individuals which are unique, unrepeated, and indivisible.for the entire biological cycle.

4th level Vertebrate animals in which the maintenance of the DNA variability typical of the species and its intraspecific variability is assured by socialization defined by the interaction of internal and external factors (A: mother-offspring relation; B: sexual partner relation; C: cooperation in food research; D: cooperation in defence) and quantitative formula could be created to give the maximum and minimum number of individuals who could survive in a certain environment.
$(A+B) + K(C+D) = \Delta$

5th level Mankind in which the maintenance of the DNA typical of the species and to its intraspecific variability is assured also by the product of the brain activities (history, traditions etc). In this case Ethics can also become Moral Code as the four types of socialization input can be influenced by history.

Fig. 2 - The definition of Bioethics: "Preservation of the DNA typical of the species and maintenance of its intra-specific variability"

All these forms, also according to the Hindu and the Schweitzerian traditions, are worthy of respect and of ethical consideration. However, the ethical consideration varies and has a different weight according to its biological complexity and its ontogenetic cycle.

A first hierarchical level of value must be attributed to the specific DNA of a biological entity characterized by a haploid order of genes such as those of a bacterium, a gamete, a spore or a haplophyte. They differ from the one we must attribute to a biological entity characterized by a diploid order of genes. The fusion of the two haploid DNA filaments presupposes meiosis, which functions as a selective filter of casual mutations, the majority of which leads to the extinction of the haploid entity.

The diploid entities represent therefore a second hierarchical level leading to complexity in the history of life, which deserve merit in themselves.

But the ethical concern is different if the diploid biological entity has a) no prospect of autonomous survival, as in the case of an embryo, or b) if its reproductive cycle has already been completed, or c) if it is made up by individuals whose existence is thoroughly independent of the transmission of the specific DNA (as in subordinate classes of social insects or in the cutting).

This situation of uncertainty perspective restrains bioethical evaluation.

In the case of the embryo the contribution of the biological entities to the preservation of the specific DNA and its variability in the following generations infect has very few chances, because their existence and their reaching the level of individuals are conditioned by many environmental incident or predation which eliminate most of them, as happens to seeds in plants and fertilized eggs (embryos) in animals.

In the case of entities after having completed their reproductive cycle, they are biologically useless, and therefore their existence has lost biological significance although they can have a biosocial significance in some species of animals. Their survival is mainly a surplus for the population.

In the third case, the subordinate classes of social insects, their existential meaning is limited to their mere existence. In life hierarchy these conditions are not considered as complete and their life is limited to their specialized differentiation and for a specific service in their biological community.

In plants and in lower animals there are diploid biological entities, like cuttings, to which it is not possible to attribute the concept of individual, since although they carry the specific DNA, they do not have any variability. They are all identical copies of their parent entities; they perpetuate by subsequent fractionation without sexual reproduction.

These entities lack individuality and do not allow the perpetuation of the genetic variability of the species; they are living entities, but do not have the same characteristics as individuals.

We are instead interested to consider the ethical norms of those animal species in which the concept of individual is present, individual being defined as a biological entity characterized by uniqueness, unrepeatability, indivisibility for the entire ontogenetic cycle (in other words, individuals resulting from the fusion of gametes produced by the meiotic process of parental generation) the germinal line is potentially active in all individual members of the population. This is the third hierarchical level of complexity in the history of life.

In these groups of living beings the preservation of the characteristic DNA of the species and its intra-specific variability is ensured by precise rules of socialization. Therefore the ethical norms of these species are conditioned by the biological stimuli of socialization (Fig. 3).

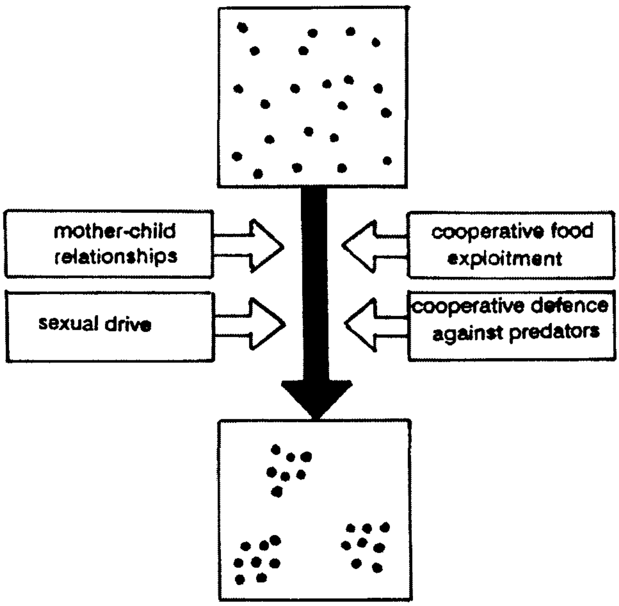

Fig. 3 - The four stimuli which create the social organization

Thus ocialization means the stimuli which serve to perpetuate the characteristic DNA of the species and its intra-specific variability.

These stimuli are:

a. parental care

b. reproductive behaviour

c. co-operation in the search for food

d. co-operation in defence of the group

These stimuli are the target of ethical rules governing the social organization of Vertebrates, Man included. They could also be quantified.

While A and B are strictly dependent on the biology of the species, C and D are related to environmental conditions. It is thus necessary to introduce for both these last two factors a constant, k, related to the environmental conditions in which the species or the population happen to live.

So, these four factors, independent each other, are the entities upon which the ethical norms of the third hierarchical level in the natural system are developed.

These four factors may be quantified in terms of consumption of necessary energy (Calories) and amount of time invested (Time) in the fulfilment of the ethical imperative of the reproductive process. This allows one to arrange them in an equation whose result ought to give the minimum and maximum size (δ) of the population of a given species that can survive in a certain area.

$$(A+B) + k(C+D) = \Delta$$

From a genetical point of view, this delta identifies the concept of "deme" which in a local panmittic population determines the minimum number of individuals needed to guarantee genetic variability, that is essential for subsistence of an unlimited number of generations.

In this definition of "deme" the essential presence of the genetic variability is stressed. In order to keep constant the frequency of genes in a population, four conditions are necessary:

1)absence of selection
2)panmixia
3)absence of mutations
4)absence of differential migrations

Therefore he minimum number of individuals in a population must take into consideration these four factors.

The maximum number of the individuals of a population in a given territory, besides depending on the supporting capacities of the territory should also take into account the conditions mentioned above; therefore, a population could not be made up by individuals of one sex only and should include individuals of different ages.

From this formula, which may be applied to all vertebrate species (Mammals in particular), it is possible to derive one that is more specifically suited to Man for his cultural development, which can be generally indicated with an exponential function of human intelligence (e^i). For Mankind the formula will be written as such:

$$[(A+B) + k(C+D)]\, e^i = \Delta\,(H)$$

This socio-intellectual control on the environment in the natural system can represent the quality rise leading to the fourth hierarchical level of ethical norms.

Also in this case is the minimum and maximum limits of "delta" (H), where Δ (H) represents the number of individuals utilizing a certain territory, that impose the ethical norms of behaviour for our species. For this reason the minimum or maximum number of individuals that constitute the "deme" may vary according to different environments in which various populations live in the different historical contexts. In other words, it is the interaction between the biological characteristics of the species and the productivity of the territory (even if in the case of Man this may be increased by the intellectual ability of the human brain), that contributes to determine the ethical norms that characterize the historicized behaviour (morals) of the different human populations.

The adaptive choice of the human social structure and the ethical choices (including biotechnological and biomedical ones) must depend on this interaction between human population and natural environment in which they live.

This equilibrium must be maintained or looked after for the very survival of our species.

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