The Bioethics of Biodiversity[1]

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INTRODUCTION

Life, one may argue, is the single most striking and interesting characteristics of Earth. A wealth of organisms of all shapes and dimensions occurs pervasively everywhere, in all sorts of regions, depths, altitudes, climates or temperature ranges. These organisms are grouped in different populations, belong to different species, interact in a variety of communities and ecosystems, and may be individually differentiated at genetic level. Biodiversity, or biological diversity, refers simply to all this immense diversity and variety of living beings of this planet – not more, nor less, than that.

The simplicity of this concept does not prevent many erroneous or incomplete ideas on its real meaning and scope to prevail. For instance, there are those that associate biodiversity to the specific case of endangered species, and particularly to those wild vertebrates known as charismatic, or flagship species, such as eagles, wolfs, lynxes, pandas, whales or elephants. But if biodiversity includes everything that is alive, then it is obvious that its problematic is not restricted to this kind of species. Charismatic vertebrates are surely very relevant, and they do fairly deserve conservationist priority, regardless of the fact that they are appreciated by so many. But biological diversity extends to worms, parasites, mites, lice, spiders, insects, bacteria, algae, medusas, fungi, trees, weeds, bushes, fish, frogs, serpents, lizards, rats… In sum, to all a variety of beings whose existence we are all more or less aware of and to an imm-ensity of other beings unknown to most of the people.

Biodiversity also tends to be associated to more or less remote territories, away from our daily life and involving reality, such as tropical forests, mangroves, coral reefs, exotic islands. Or at most, some associate it with protected areas, natural parks and reserves, as if the essentials of the issue would or should be restricted there. Of course, tropical forests and islands are extremely rich ecosystems, where some of the most stringent problems of biodiversity occur, while protected and classified areas may and should, by definition, contain many of its most relevant components. Yet, what is essential to keep in mind is that the preservation of biodiversity is determined everywhere in the planet, from the most remote regions to our nearer coasts, cliffs, seas, estuaries, rivers, streams, prairies, swamps, fields, woods, mountains, villages and cities. The fate of the diversity of Earth's living organisms, including those inhabiting distant places, is also determined at our homes, at our tables and meals, by the clothes we buy and our leisure, through our consumption patterns, activities, options and values.

For operational reasons biodiversity is usually approached at three levels – that of genes, of species, and of ecosystems. The genetic level refers to the fact that individuals of the same species diverge at the level of their genetic constitution, through the different forms (alleles) of their genes. Thus, within the same species there are differences between individuals and between populations, i.e., there is diversity at intra-specific level. The species level is the most obvious and popular, in accordance with the common empirical perception that living beings belong to different kinds and types, which are called and recognized as different species. The ecosystems level, finally, points to the fact that the ways in which living organisms get organized, interact and inter-depend in their habitats constitute a further aspect of the diversity of life on Earth.

An argument that can be found in debates on nature conservation, including the biotechnology debate, is that the concept of species would be somehow artificial, blurry or imprecise, and thus it would not serve as a good criterion for whatever decision-making. Well, this is not so. In spite of the inherent difficulties of the concept, the biological sciences regard species as clearly recognizable entities. The most common definition of the biological concept of species asserts that a species is a population of individuals who may interbreed in natural conditions. There are of course other definitions, as there are exceptions and organisms to which this concept cannot apply, but this is only a reflex of the diversity and complexity that characterizes the living world. By themselves, they do not diminish its validity. And the species is, and is likely to remain, the most relevant and useful unit of biodiversity. As Edward O. Wilson (1992, p.38) has put it, the species is "*the grail of systematic biology*".

THE ENVIRONMENTAL CRISIS, ETHICS AND BIODIVERSITY

There is a widespread and prevailing recognition that the world is facing some kind of general environmental crisis. Denials of this diagnosis do exist, but most often what may be questioned is the extent of the crisis, and not its sheer reality. The idea that the global environment is in trouble goes along with the idea that there is also a biological diversity crisis going on. In fact, the reduction of biodiversity is usually presented as one of the so-called global environmental problems, along with the ozone layer depletion, climate change or other possible descriptors. This change may indeed be approached as a degradation of the physical environment, such as pollution by toxic waste and compounds, over-exploitation of water resources, increase of greenhouse gases, soil erosion and desertification, etc. Yet, there are reasons to maintain that the global environmental crisis may be simply faced and described as biodiversity loss. From this point of view, the biodiversity question is not only one more of the environmental problems of the world; rather, it is THE global environmental problem, the biggest, the widest, the most widespread, and the one with the most profound ethical implications.

Might this be an exaggeration, an undue biological reductionism? To prove that it is not so, let us look at the foundations of environmental ethics. For a long time, the main subject of conventional ethics was the concept of Right and Wrong with respect to human beings. Environment as such was not usually a moral question. It was the notion of the environmental crisis that instilled the emergence of environmental ethics. In any of its three main currents (Callicott, 1995; Larrère, 1997), anthropo-, bio- or ecocentred, environmental ethics gains a context through living beings either as valuable to attend to human interests, or as ethically pertinent to individuals, or as grouped in supra-individual entities morally relevant as such. Thus, the degradation of the physical environment may only gain meaning through the existence of living, including humans, which may suffer from its effects. Let us try a mental experiment to fully capture this. Suppose any other planet from the solar system totally devoid of life. Imagine that Humankind would find a way, technologically and economically viable, to export and deposit there several types of toxic waste. Should this option raise moral concern from the point of view of the impact on the recipient planet? Would this risk to be an unacceptable "environmental pollution" of that planet? It seems hard to invoke and justify the preservation or "well-being" of any such "environment" devoid of living creatures. Moral concern on what is right or wrong to do with the environment can only gain a sense in regard to its consequences for Life. And in fact, all the global environmental questions can only be threats or problems because they have a negative impact on living organisms, including human beings, and on their life support systems. In other words, all these problems have an incidence, affect, and reduce, biodiversity.

There is a further reason to consider biodiversity loss as the most relevant of the global environmental problems, which is that, at human scale, it is the only truly irreversible problem. The ozone layer has been shrinking, but we know just now that, if the appropriate decisions on non-emission of ozone damaging substances are taken and kept, it will fully recover in not much more than a pair of generations. Climate change is becoming a recognized reality, but if the greenhouse caused by gases emissions one day significantly shrank, we might foresee that, in spite of the considerable uncertainty of climate determinants, the situation could be reversed in a scale of decades. Pollution of several types may become widespread, but we can estimate that usually (with the probable exception of some forms of radioactive pollution) time and nature can manage to recover most situations in a reasonably short time-scale. But yet, when a species gets globally extinct, we know that it is absolutely impossible to recover it or to re-create it again. Below we will see that, at the adequate time-scale, the level of biodiversity, in the sense of the quantity of different life forms, may in fact be re-established. But we will also see that that time-scale is totally supra-human. In other words, extinction is really forever.

The close relationship between environmental ethics and biodiversity, thus, is easy to intuit and understand: the latter provides a justificatory background for the reasons and theories of the former. But what might be the real relevance of ethics for the biodiversity question? Ethical considerations entities do tend to appear as such in textbooks on conservation biology, although they are usually presented as a mere epilogue of other considerations implicitly assumed as more central or pertinent, such as economic, social, scientific, aesthetical or others. Yet, morality may be duly understood as the effort, mediated by reason, to do what the best reasons suggest (Rachels, 1999, p.9-10), and for this effort all kinds of good reasons should be taken into account. In a way, then, all kinds of arguments contribute and are a part of the ethical analysis of biodiversity issues. On another side, it is ethics, when consolidated and passed into practice, that holds the real power to influence and determine the route of human societies. Thus, ethical considerations are in fact fundamental for our subject.

It is understandable that those regarded as advocates of nature conservation, or those that are linked by training or profession to the preservation of biodiversity, tend to know for a fact assumptions on what is good and what is bad, on what is right and what is wrong. But often these kinds of assumptions are not grounded on adequate ethical reasoning, and may come to lack appropriate justification. For instance, the following have been proposed as ethical and ideological statements of conservation biology (Primack, 1995, p.8-9): (*i*) *The diversity of organisms is good; (ii) The untimely extinction of populations and species is bad; (iii) Ecological complexity is good; (iv) Evolution is good; (v) Biological diversity has intrinsic value.* This kind of assumptions may seem intuitively valid to those who hold a conservationist attitude. But what about those many that do not hold such view, or just never worried much about conservation biology? How will they face this kind of statement? Which might be their alternative statements on biodiversity? How could contrasting assumptions be argued and debated for the sake of deciding what we ought to do with biodiversity? For conservationists, then, much more important than assuming as valid certain a priori statements, it will be to consolidate their underlying reasons, to know how to justify them, how to back them with solid arguments, how to firmly explain them to those that do not share the same assumptions. To evaluate the soundness of those or other assumptions and arguments, though, it is necessary to start from facts and empirical observations on biodiversity.

BIODIVERSITY IN THE GEOLOGICAL PAST

It is time to take a look at what we know about the history of the biological diversity. What can the fossil records tell us about the levels of biodiversity through the geological eras? [Fig. 1]. Grossly, they tell us that the diversity of living forms has increased with time. It was not a steady and continuous increase, as there were several ups and downs, meaning that there were periods of decrease in biodiversity, followed by periods of increase at a quicker or slower rate. But clearly and overall, the number of life forms on Earth has come to increase, and thus diversity to accumulate, through the ages. Some of the periods of reduction were particularly acute, so acute that we call them mass extinctions. We know five of them, the most ancient of which occurred around 440 million years ago and took out around 50% of living organisms, while the most recent – and also the most widely known, as it took out the large majority of dinosaurs, together with a total of around 75% of all organisms – occurred about 66 million years ago. A further aspect we know is that, after each crisis, and even in the case of the major extinction spasms, the levels of biodiversity were finally recovered and even surpassed, through evolution and diversification of new forms in the coming periods (Raup, 1988; Wilson, 1992).

We can conclude, thus, that biodiversity spasms of huge dimension are not new in Earth's history. And more than that, they seem to be recoverable! Where does it lay, then, the irreversible and unrecoverable character of species extinctions mentioned before? Well, by no means the recovery of the number of species implies the recovery of the same species. On the contrary, it was necessarily through speciation, i.e., through the formation of new species evolving from the extant species, that the recovery took place. But in order to capture the full meaning of the irreversibility of biodiversity loss, it is essential to first capture a notion of the dimension of the evolutionary time involved in the recovery.

How can we, poor human beings that measure time in hours, days, years, get a grasp of the vastness of time at geological scale? The classical form to do it, abundantly illustrated in textbooks, consists in concentrating the age and history of Earth in one single year, and then highlighting how that would make humankind emerge in the very last moments of the last hour of the last day of December. But let us try a further exercise, exploring the familiar unity of one hundred years, the century. A century is almost an eternity for beings like us, whose lifetime hardly reaches it. But one century is just an instant at geological and cosmic scales, where time is measured in millions and thousands of millions of years. One million years corresponds to not less than ten thousand centuries. The origin of life on Earth is estimated to have occurred 4 billion years ago; in other words, 4 thousand million years ago; in other words, 4 thousand periods of 10000 centuries. Since we started counting our western calendar, 20 centuries have passed – this means that a further 9980 centuries must pass before we reach the first million years A.D.! Will this help us to conceive as one million years is really a lot of time for us, human beings?

What the fossil records has been telling us for long, and is confirmed by recent studies (Kirchner and Weil, 2000), is that the levels of biodiversity

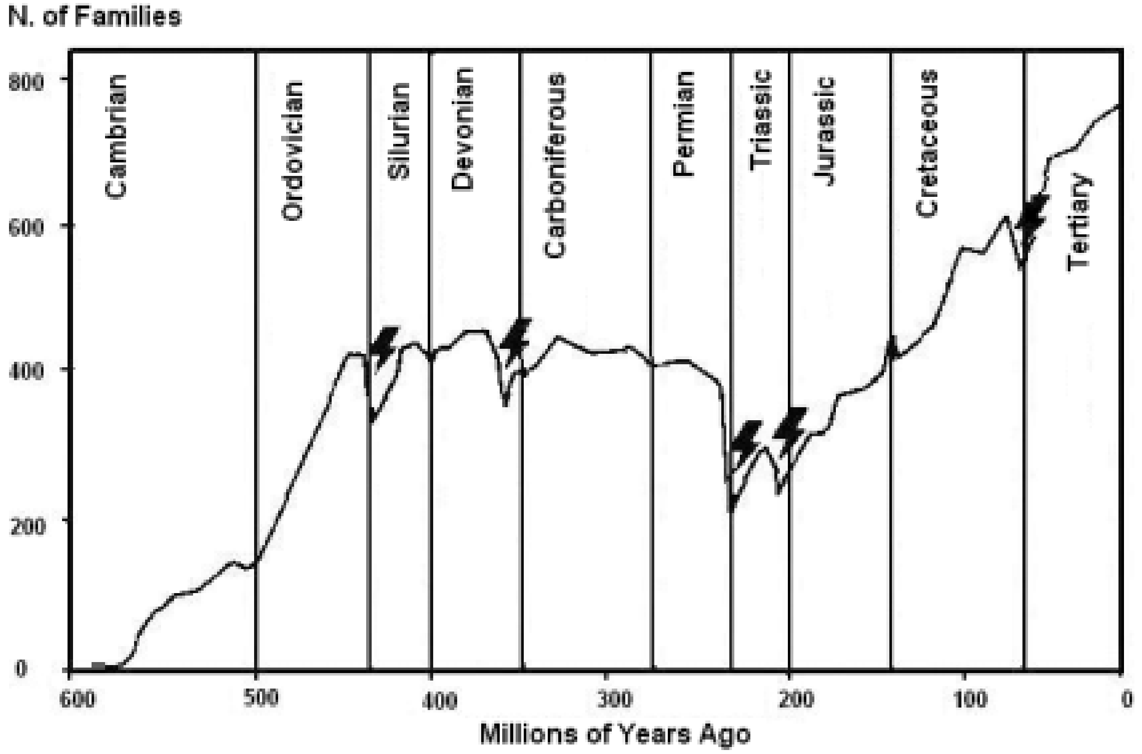

Fig. 1. Biodiversity through the ages. The figure refers to families of marine organisms. It shows that biodiversity increased slowly through the geological eras, with occasional declines through global mass extinctions. Five of these extinction spasms are known, as represented by the lightning flashes. They were followed by periods of recovery of the biodiversity levels [Adapted from E.O. Wilson, 1992].

recovery after the great extinction phases is measured precisely in millions of years. In general, as much as 10 million years is the time that elapses between the extinction spasms and the peak origination rates of new taxonomic groups. The conclusion is sharp and clear: the loss of biodiversity is irreversible at human scale. And that is definitely the scale that matters for us.

This analysis should be enough to eliminate one common error among the general public less knowledgeable about biological sciences, i.e., the idea that while some species may be lost, others are created through evolution. It may be true, but only with an insurmountable mismatch of scale: the rate of species loss may be measured in days, months or tenths of years, while the rate of speciation is better measured in millions of years. The regeneration of biodiversity is involved in an inescapable supra-human dimension, which implies that any glimpse of eventual recovery of the present biodiversity crisis lies beyond any scenario relevant for both the present and the future generations. Again, the famous biologist and naturalist Edward O. Wilson, champion of biodiversity, has expressed it eloquently in 1980 (Wilson, 1994, p.355):

"The worst thing that can happen, will *happen, is not energy depletion, economic collapse, limited nuclear war, or conquest by a totalitarian government. As terrible as these catastrophes would be for us, they can be repaired within a few generations. The one process ongoing in the 1980s that will take millions of years to correct is the loss of genetic and species diversity by the destruction of natural habitats. This is the folly our descendants are least likely to forgive us."*

FACTS AND NUMBERS ON BIODIVERSITY

Some pertinent facts and numbers on biodiversity may be useful for a better understanding of what is at stake. Since life originated in this corner of the cosmos, around 4 thousands tenths of thousands of centuries ago, it has taken many shapes indeed. If we look to all the species that have once existed on Earth since the origin, it can be said that over 99.9 % of them are now extinct. This does not refer to any giga-extinction spasm, but rather to the fact that, given enough time, the usual fate for any single species is extinction, as a result of the inevitable and creative game of natural selection and biological evolution.

Some spirits less prone to conservationism might find here the pretext to *laissez faire, laissez passer*: after all, if extinctions are natural and inevitable, why should we take the trouble and spend resources on endangered species? Again, there is a gross error in scale in this kind of argument. The natural extinction rate of species is measured in time unities with many zeros, while the human-induced extinction rate may be measured in years or days. This great ape that we call Man is not obliged to say an eternal goodbye to his evolutionary fellow species more than is imposed by the natural extinction rate, added to the induced extinction rate. Normally, without unexpected cataclysms, the former would be clearly low and irrelevant in the human time-scale context. While the latter is self-inflicted as it results from our individual and collective actions, options and preferences. Thus, the level at which we would wish it to be is open to question, and it might eventually be determined by our enlightened choice.

Any estimates on the figures that may represent and describe global biodiversity are necessarily difficult to get with precision. The total number of extant species in the biosphere is estimated between 5 and 100 million (Wilson, 1992; Stork, 1997), with 14 million being considered as a good working basis (UNEP, 2001). Of this total, only a fraction of around 1.7 million are known and scientifically described [Table 1]. Of these, it is estimated that only around 10 % has been the object of study more detailed than a gross anatomical description for taxonomic purposes (Purvis and Hector, 2000). Taking into account that each species represents a unique thesaurus on its own biology and evolutionary history, on the solutions, constraints and contingencies that allowed its adaptation and survival, we may imagine the enormous wealth of knowledge accumulated in life forms, waiting for sampling and processing.

Table 1: Estimated numbers of described species, and possible global total. These estimates are inevitably incomplete as there are new species continually being described by taxonomists. The figures for animals include a large majority of insects (ca. 8 million of the more than 10 million estimated). The estimates for the total of existing species may be highly inaccurate, p.64. [Adapted from UNEP 2001]

Kingdoms	*Described species*	*Estimated total*
Bacteria	4 000	1 000 000
Protoctists	80 000	600 000
Animals	1 320 000	10 600 000
Fungi	70 000	1 500 000
Plants	270 000	300 000
Total	1 744 000	ca. 14 000 000

Of the total of extant species, around 90% are microbes, worms, bugs, or, in general, organisms whose dimensions are measured in millimetres or centimetres. The number of eukaryotes – those organisms that have an organized nucleus in their cells, grossly more complex than bacteria, and which are mostly plants and animals – is estimated at 7 million (Pimm and Raven, 2000). It would be hard to find better figures to illustrate that there is much more in biodiversity than the conservation of vertebrates, either charismatic or not.

As it can be inferred from the figures above, the diversity of organisms in the biosphere is far from being well known and studied. There are vast arrays of biodiversity waiting to be revealed at all levels, from genes to species and ecosystems, and not only at microscopic level. The discovery of a new species of vertebrates is always a piece of news, but it is far from constituting a rare event. Up to today, it is not unusual to see a new species of large vertebrate found and described, from fish to lizards, monkeys, ungulates or even cetaceans. The mean number of new species of all types described in the scientific literature, from bacteria to plants and animals, is estimated at around 300 per day, and this figure does not seem to decline (Purvis and Hector, 2000). Of course, this does not mean that new species are "created", rather that new species are found in nature, where they have been for long. Yet, it is mainly within the microorganisms that there is more biodiversity to explore. Still nowadays, and namely in the ocean bottoms, new forms of life are found, so distinct from any other known forms that they receive the higher taxonomic categories, either that of Phylum, or even presumably that of totally new Kingdoms. On another side, molecular biology techniques applied to systematics frequently reveals that what was thought to be a single species is actually two, three or more sibling species, morphologically cryptic but genetically differentiated. This splitting of species tends to occur at a higher rate than the cases of recognition of presumed different species that are actually the same. At ecosystem level, some habitats are particularly poorly studied, such as the tree canopies of rain forests or the ocean bottoms, in particular the hydrothermal vents, which are rich in very peculiar microbial life forms. There are whole groups that remain largely unstudied, of which the bacteria are paradigmatic. Thus, the world is still fertile of new and old dimensions of unknown or hardly known biodiversity.

A further aspect to take into account is that the geographical distribution of diversity is far from being homogeneous. There are regions of immense levels of biodiversity, of which coral reefs in the ocean and tropical forests in the land are classical examples. In certain zones, such as the poles or the deserts, diversity is contrastingly much lower, while there are all kinds of intermediate situations all over the world (Gaston, 2000). A useful concept is that of biodiversity *hotspots*, which are regions of exceptional concentration of endemic species, i.e., those that exist only there. It is estimated that in these hotspots 44% of all species of superior plants and 35% of all species of vertebrates, except fish, is concentrated. These 25 hotspots correspond to only 1.4% of the land surface of the planet, from which one may infer their priority character for nature preservation. But ironically, these same areas are also suffering from an exceptionally high rhythm of loss of natural habitats (Myers et al., 2000).

The geographical heterogeneity of living organisms distribution may originate a wrong attitude that also affects other global environmental questions, such as climate change, i.e. the very human tendency to "*let-the-others-do-it*". In the developed countries, the temptation could arise to alleviate their share of responsibility, on grounds that most of diversity is found in the Third World countries. In these countries, the temptation may arise to consider the whole of the biodiversity question as unfair, in the sense that it could imply for them the greatest burden of effort and responsibility, while hampering their development objectives. This is a simplistic way of seeing things, of course, but it may lead us some a small step from concluding that human societies get rich and developed precisely at expenses of biodiversity. It seems to be a fact that there is no positive correlation between the wealth of nations and their levels of biodiversity, but it is obviously abusive to conclude that the lower the biodiversity gets, the higher the income. Even more abusive would be to infer that the loss of biodiversity is a condition for human development. We will see below how the history of civilizations rather shows that such loss may bring serious consequences for development and for the long-term viability of societies. We will also see that there are well-grounded reasons to consider that biodiversity should rather be seen as a fundamental basis for social and economical development sustainability. If the biodiversity crisis is to be considered as a serious global concern, then the responsibility for its resolution is not attributable especially to the countries where it is most abundant, but rather to all humankind.

CAUSES AND MEANING OF THE BIODIVERSITY CRISIS

Returning to the history of biodiversity on Earth, how can we describe its present situation? Rather simply, the biosphere is crossing a further extinction spasm, the Sixth Great Extinction. The evaluation of the rate at which species are currently getting lost today is no simple matter, as it is clearly much easier to demonstrate that a species does exist than that it got extinct. It is not surprising then, that controversy on the size of these estimates may occur. However, what is noticeable and should be stressed here is that whatever the estimate, whatever the author, the occurrence of a major extinction spasm in the present does not seem to be seriously disputable. Recently, Bjørn Lomborg (2001), a Danish statistician, launched a major critique to environmentalism, claiming to show through the analysis of global data that the state of the global environment is actually getting better. We do not need to comment here on the validity or not of his conclusions, as that has been done elsewhere (e.g. Grubb, 2001; Schneider et al., 2002), and as for our goals it will suffice to look at the implications of his figures on biodiversity – *if they were valid*. Estimates of species extinction rates are certainly difficult to do with accuracy, and this is coherent with the wide variety of inconsistent estimates made by several scientists (Lugo, 1988; Stork, 1997). Most authors have concluded that the present extinction rate is higher than the natural rate by a factor of 100 to 10000. Lomborg criticises the evidence for some of the most high estimates of species loss, such as those which anticipated as much as 40 000 or 27 000 per year, or 25-100 % in some few decades. He rather reaches the much lower figure of 0,7% per 50 years, or 0,014 % per year. What is remarkable, though, is that Lomborg himself concludes that even this low figure implies that the present rate is 1500 tmes higher than the natural one. Furthermore, if he is right and if the rate kept constant, 0.014% of all species per year would mean that in some few thousands years a large proportion of all biodiversity will be brought to oblivion. Surely, it might be argued that thousands of years are also far from the normal time-scale at which humans operate, but the main point I wish to make is that this rate would still mean that an extinction spasm is under way, equivalent in magnitude and rate to the great spasms known from the fossil records. In fact, if the extinction crisis of the past occurred relatively quickly at geological scale, still they are likely to have extended through millennia. If the present anti-pope of environmentalism was right, then, the biosphere would be facing one of those large scale crisis that reshaped its future, and that will take several million years to recover. If he is not right – and there are reasons to believe he is not (Myers, 2001; Pimm and Harvey, 2001; Wilson, 2001) – with other higher estimates turning out to be right, such as those suggesting that up to 20% of all species may get extinct in 20 years, or that at least 25% of all species is likely to be lost in the next 50 years, then the present crisis would just be much more serious.

The Sixth Great Extinction may be similar or more profound than the other great crisis of the past, but it does have one undeniably original aspect. For these ancient spasms, the exact causes are not clear, with speculation ranging from enormous volcanic eruptions to impacts with celestial bodies. But for the present crisis, though, the ultimate cause is known with precision, and without relevant signs of controversy within the scientific community: it is the direct and indirect activity of one species only – ours, the human species – which is causing the reduction or disappearance of other life forms.

The causes of the present crisis have a human origin, them, but what are those causes exactly? At the top of the direct causes habitat destruction prevails (Chapin et al., 2000; Pimm and Raven, 2000). It is not industrial pollution, nor the ozone layer depletion, nor global warming. Important as these problems are, it is rather the bulldozer in action, the spreading of urban areas, the construction of dams and artificial lakes, the opening of new roads, the conversion of land uses, the action of trawler nets in the oceanic bottoms, etc. – in short, all those human activities, undoubtedly necessary, but which tend to be practiced everywhere at large scale and without much care or criteria. The other causes come next, and albeit relevant and serious as they also are, they do not have the same prevalence. Without reference to their hierarchy, they include: fragmentation of natural habitats, meaning their reduction to small and isolated areas that can no longer sustain viable wild populations; the degradation of natural habitats through pollution and other factors that, without necessarily destroying them, do reduce or eliminate the conditions to sustain life; the direct persecution of species for economic goals or other goals; and the introduction of exotic species, i.e., the displacement of species from their areas of origin to ecosystems to which they do not belong, and where they may pose serious ecological threats to the autochthonous species, particularly in freshwater ecosystems. In sum, the causes are always of human origin, resulting either from deliberate or from accessory actions undertaken everyday, virtually all over the world.

The real meaning of the biodiversity crisis and of the peculiar destructive power of humankind on the biosphere deserves to be put in due context. One strong idea that is often advanced in relation to global environmental problems is that humankind may come to exterminate all life on Earth, or that it may actually be in the course of doing it. Let us bring things to their right proportion: the power to eradicate all life forms from this planet is totally beyond human capacities. Imagine the worse possible scenario, such as the one resulting from a global and generalized thermonuclear war, brought to the last missiles, arsenals and consequences. It is quite possible that this could drive humans themselves to extinction, especially with the outcome of a radioactive world and a disrupted biosphere. A wide proportion of the species that are their unfortunate evolutionary partners would surely be gone too. But would this mean the end of Life on Earth? That is most unlikely. To understand why, it is enough to remember the extraordinary dispersion of organisms and microorganisms in the most varied, remote and unreachable ecosystems. Even under the most dark and persistent "nuclear winter", there would exist those bacteria that strive in the deepest bottoms without requiring any exterior inputs, as they use the chemical energy of simple compounds to live, without any need of light. Furthermore, other organisms are remarkably resistant to adverse environmental conditions. It is not even totally assured – only probable – that a nuclear holocaust would necessarily doom the human species, which is also considerably adaptable and resistant… But this exercise of imagination should serve to help put in the right perspective the meaning of the biodiversity question. What is at stake is not Life on Earth as a whole, but rather Life on Earth as we know it, as we appreciate it, as it evolved with us, as it expanded into a dazzling array of variety and complexity. What is at stake, in sum, is the full quality and dignity of human life, which depends, as we will see, from the remainder extant living organisms. It is not the biosphere that depends on humankind; it is humankind that depends on the biosphere.

BIODIVERSITY IN HUMAN HISTORY

For many people, the environmental troubles of the world are mainly a matter of today, arising essentially during the XX century. This revised version of the "*mythe du bon sauvage*" is very widespread, particularly in terms of nature conservation. One way or the other, under this kind of vision it is assumed that there has been some kind of past "Golden Age" in which humanity lived in harmony with other species and with biological resources, without any trace of induced extinctions or similar calamities. Yet, archaeological and historical evidences are accumulating against any idyllic vision of our past. Thus, and also because this tends to be underestimated in conservation biology textbooks, it may be useful to review what is known on the relationship of our ancestors with biodiversity through several episodes of the past.

The human primate – or the "human chimpanzee", or "third chimpanzee", as we might duly call us (Diamond, 1991) – has probably started spreading through the world and out of Mother-Africa some 30 000 years ago. By chance, the biosphere was then at one of its maximum biodiversity peaks [Fig. 1], and not on one of the occasional downs. The plain fact is that there is now enough evidence to conclude that the history of human expansion towards each new geographical area, continent or island, was essentially a history of steady reduction of biodiversity, and especially of induced extinctions of the mega-fauna, those animals large enough to make them suitable to be hunted and consumed (Diamond, 1991; Ponting, 1991). These biological clashes of the past are documented at continental scale. Around 10 000 years ago, the first human groups are thought to have reached America through the north, while approximately at the same time there are records of extinctions of many species of the mega-fauna, such as horses, giant ground sloths, camels, mammoths (Diamond, 1991). The thesis that this was likely the result of climatic changes is now under retraction, in favour of the thesis postulating that the extinctions resulted from direct persecution by the newly arrived primate predator. In Australia, the first people arrived around 50 000 years ago, and by the same time many local species started vanishing, due to the same presumable human causes, and predation in particular (Roberts et al., 2001). In one case and the other, the rate of extinction of mega-fauna may have reached as much as 76 to 80 % or more.

Islands provide what are probably the best examples of human impact on biodiversity. New Zealand, for instance, is a paradigm of what was likely to happen when human beings reached a new environment. It is a remote island, far away from the nearest continental areas, that as a result of the distance had not been colonized by mammals. Birds, thanks to flight, did. Through eons of evolution they had expanded, diversified, given rise to many new species and occupied the generality of those ecological niches that we are used to see occupied by mammals. The first mammals finally arrived in the XIII century. They were human: that is when the Maori discovered the island and colonized it. And they brought other fierce mammals with them too, such as rats. It was known for long that around the same time New Zealand birds had experienced a wave of extinctions, particularly the biggest birds. What was not known, but is now demonstrated beyond any reasonable doubt, is that the cause was basically of human origin. In around 160 years twelve species of moa, those enormous endemic birds, were hunted and exterminated down to the last one (Diamond, 1991; Holdaway and Jacomb, 2000). With them, many other species disappeared because of the direct or indirect action of our own species. Not because the Maori were mean, of course. Rather because the human being is an opportunist predator who feeds on whatever he can, who has special skills to produce and use technology, but who does not show a tendency for the rational and sustainable use of resources. The introduction of other species and the arrival of Europeans have increased the extinction trend. The result is that New Zealand now has around half of the pre-human birds species, several of them endangered.

The same general pattern may be found in many islands colonized by humankind (Diamond, 1991; Steadman, 1997). In Polynesia, around 50% of bird species was already extinct before the contact with Europeans. In Madagascar, several mega-fauna species, including giant tortoises, a pigmy hippopotamus, giant lemurs, enormous elephant-bird species, and others, were gone before the arrival of Portuguese navigators due to the activities of the autochthonous humans. Eastern Island is often cited as a parable of unsustainability (Ponting, 1991). In this remote insular microcosmos, very far away from the nearest continents, a civilization collapse occurred as a consequence of overexploitation of biological resources and total deforestation of the island by its human inhabitants between the years 400 and 1500. This resulted in a dramatic reduction of the carrying capacity of the environment, and in a generalized social degradation that led to small tribes engaged in warfare and cannibalism, as when the Europeans found them. Practically in every sea and ocean where humankind reached new insular territories, from the Pacific Ocean to the Mediterranean Sea, humans caused acute local biodiversity crisis, particularly within the birds. Even in coastal and marine ecosystems, evidence now exists for historical overfishing (Jackson et al., 2001), showing that the overexploitation of living resources through human history was not confined to terrestrial ecosystems.

This re-interpretation of human history that emerges through eco-archaeology includes several past civilizations that declined due to what is now presumed to be the unsustainable basis of their relationship with the natural environment. The examples include the Mayas of Yucatan, the Anasazi of North America, several civilizations of the Middle East (Assyria, Babylonia, Persia, Petra), and even the decline of the Roman Empire and of Ancient Greece (Diamond, 1991). But there are also reported exceptions to this pattern, usually small, long-established societies that seem to have developed an approximately sustainable way of life. And there is the apparent exception of Africa, where only nowadays the mega-fauna is increasingly endangered. Maybe the explanation has something to do with our African origin favouring the progressive adaptation of other species to the predator that the human primate is. But the general conclusion is clear, and should be taken into account in any environmental analysis of what may be happening nowadays at global scale: there is no innate environmental ethics in humankind, nor any spontaneous tendency for a sustainable and enduring relationship with the environment and with biodiversity (Ridley, 1996).

From this, some might argue, it would follow that a human induced biodiversity crisis is inescapable and unavoidable, as it is pre-determined by our own biological and evolutionary inheritance. Or, taken to an extreme, our past as hunters and predators might be invoked to legitimate our ongoing predation over the remainder biosphere, arguing for the "duty" to follow our innate nature. But what would be of ethics, of our social relations, of our societies, if everything that allegedly originates in our instincts and in our evolutionary past was morally acceptable a priori? And why would the innate tendency of many humans for what has been called "biophilia" (Wilson, 1984), a kind of special devotion to nature and to other forms of life, be less inborn or less legitimate? After all, the environmental tragedies of our past may well point to an "evolutionary need" of more, not less, of these biophiliac pulses for our viable future. Actually, the biological catastrophes of human history did not result from deliberate options, but rather from a lack of perception of complex management situations. While the present biodiversity spasm occurs under a clear perception of its causes, its scope and its meaning. The special circumstance that we seem to be the only species to date that has the power to consciously influence its environment may rather be a sign that a new conservationist stewardship of the biosphere ought to be seen as a basic moral duty. If this is the right path for humankind or not, that will surely depend on the best arguments, reasons and values that may be advanced in its favour. It is time, then, to bring our reasoning into the real value of biological diversity.

THE VALUE OF BIODIVERSITY

Up to this point we have seen some of the main questions raised around biodiversity, and we have rejected some of the possible claims against the moral relevance to preserve it. Yet, for a full evaluation of the ethical meaning and implications of biological conservation, the facts and analysis approached so far are not enough. We need to explore one central question for ethics, which is value. What is the value of biodiversity? No moral *ought* can be inferred without a value that *is*. If there is any moral relevance or moral duty to preserve biological diversity, it must be shown to be morally valuable.

Biodiversity is *par excellence* one of those holistic environmental entities that lies in the core of the attention for environmental ethics. Biodiversity includes the diversity of genes and individuals, but the essential part of it is supra-individual: populations, communities, species, ecosystems, are a great deal of what we mean when we refer to biodiversity. It is not surprising, then, that ethical arguing on biodiversity faces the same kind of challenges and difficulties that holistic environmental ethics face: how do we justify the value of a species, of a habitat, of a ecosystem?

Conventional humanistic ethics bases its theory of value on the moral significance of attending the conscious interests and desires of human beings. Animal ethics and some biocentric ethics (Varner, 1998; Agar, 2001) may be seen as an extension of the same interests-based criteria to other entities that arguably hold desires or interests, either conscious or not. But can interests or desires be invoked when dealing with holistic supra-individual entities that arguably do not hold them? Clearly, biodiversity ethics is not likely to be well grounded if it is to be based on alleged "interests" or "desires" of populations, species, communities or ecosystems. Yet, interests and desires of those who do hold them, which are either human or non-human living individuals, may certainly serve as a basis for the ethical valuation of environmental ethics (Varner, 1998; Agar, 2001).

Consider human interests, to begin with. Anthropocentric environmental ethics correctly argues that we may find good reasons to attribute indirect moral consideration for the environment and its components if we take them dully into account, as it is easy to show that the interests of present and future generations of humans need a healthy environment to be fulfilled. The same applies to biodiversity as such: it is easy to show and argue that humans benefit in several ways from the diversity of living organisms. In fact, the most perceptible way to approach the value of biodiversity is through its instrumental value, meaning that kind of value that we obtain from the several uses and benefits that come to us from other organisms.

Biodiversity provides many direct and indirect services to humankind (Daily, 1997), and thus it may be valued instrumentally from different points of view (Norton, 1987; Primack, 1995). Some of the uses of biodiversity have an obvious direct economic value, either for consumptive uses (as food, feed, fish, fibres, materials, fuels, etc.) or for productive uses (as food, skins, scents, medicines, resins, timber, genetic resources, etc.). They are those kinds of value most easily understandable and prone to be consensual, as they are both familiar and convertible into monetary value. There is a whole range of other types of economic value that, although indirect, are not less relevant. It is the case of those benefits that biodiversity brings to tourism, to leisure, to the fruition of landscapes and natural spaces. It is also the case of the social value of those employments that depend directly on biodiversity, such as in the fisheries and so many other activities; they may be seen as a further category of value apart from the economic income that these activities generate. Even the educational and scientific value of biodiversity, which is clearly enormous, may in a sense be approached as an indirect economic value, as education and science are the backbone of modern economic activities based on knowledge. A further indirect economic value is the so-called *option value*, which is the potential value of each single species to reveal a future economic use, as it is particularly apparent from the biotechnological use of genetic resources. While *existence value* is that kind of value that derives from the willingness to pay for the conservation of this or that species, of this or that ecosystem, from pandas and whales to tropical forests, only for the sake of it. Existence value is not a use value in the sense that people's motivation relates to the direct use of the elements of biodiversity in question, but it is instrumental insofar as it serves human interests – and it may also be approached as an indirect economic value (Norton, 1987; Primack, 1995). Other instrumental values in this same sense, although unlikely to be approached through economic value, are those related to the symbolic uses of nature and biodiversity: aesthetics, art, spirituality, religions, traditions, etc., are all areas that are important for human "mental welfare", and which often make use of living organisms, species or nature.

The ecological services that biodiversity offers to humankind are another important aspect of indirect instrumental value. Ignored or underestimated for long, they are those services given spontaneously and free of charge by natural ecosystems, and that in fact are responsible for keeping the biosphere and human societies functioning. As soon as ecological economics started to quantify the enormous monetary value that they may reach, the attention and consideration for this kind of service has grown (Costanza, 1991; Costanza et al., 1997). These ecological services include such important aspects as flood control, soil protection, soil production, water treatment, waste treatment, air purification, climate regulation, nutrient recycling, pollination, productivity in general, etc. It is now demonstrated that at least some of the ecological services that nature provides us are dependent on and increased by biodiversity (Tilman, 2000).

The instrumental value, under all these points of view, has an enormous potential in demonstrating the need to preserve biodiversity, especially in a world that is basically governed by an anthropocentric paradigm. Thus, one should not forget or underestimate that this way of reasoning and arguing is surely the one that finds greatest receptivity in our societies, and is as such the one which can better influence the status quo. One could be tempted to stick to it exclusively: if biodiversity undoubtedly has direct and indirect instrumental value, is not that enough to show the moral relevance of its preservation? Well, it does help, but it is not enough. A line of reasoning exclusively based on instrumental aspects has surely many advantages and potentialities, but it also has limitations and drawbacks that should be kept in mind. First of all, other economic uses or different uses may always be advanced as justification for the lesser relevance of preservation in relation to other societal needs – in fact, this is what keeps happening all the time in the real world of decision-making. Secondly, some of the indirect instrumental values of biodiversity may not yet be fully persuasive, or they may still be in need of improvement in their evaluation and quantification. It may surely be difficult to estimate with precision how many euros per year a salt marsh will be producing in sewage water treatment, although it is not less sure that it does produce such a service. That is probably why a large proportion of mainstream economics is insensitive to the relevance of ecological services. Thirdly, instrumental values may find an application to a certain fraction of biodiversity only. For instance, there is scientific evidence that the productivity of some ecosystems increases with the diversity of present species, including agrarian ecosystems (Hector et al., 1999), but if we were to verify in detail which are the species directly responsible for such increase we might conclude that only a proportion of them would be involved. This does not mean that not all species may have an important instrumental role of some sort, but rather that we may still be in lack of the appropriate tools and arguments to reveal such role.

Economic and instrumental valuation, thus, may give rise to certain lines of reasoning that not only do prevail in several sectors of society, but that would also lead to a considerably low importance of biodiversity conservation. For instance, some argue that the relevant proportion of biodiversity is restricted to those species and forms that have a direct use for agriculture, forestry, aquaculture, fisheries, animal production – in sum, that part of biodiversity that the human being actually uses, and not insects, worms, bugs or microbes in general. This is obviously a simplistic view that is easily brought into contradiction through a minimum of ecological background (what keeps the agrarian, forestry or others productive systems viable if not insects, worms and micro-organisms?), but it does have a good deal of followers. A similar version is the one that divides living organisms into "useful / beneficial" versus "noxious/ harmful", or any other similar dichotomy implying that only the elements of the "positive" group would be eligible to moral consideration or conservationist measures, while it would eventually be an advantage to extirpate the elements of the "negative" group. This is again an erroneous and obsolete vision, but it serves to illustrate the kind of conceptions that may underlie discussions centred on instrumental value. Anyway, a proper array of instrumental arguments has power enough to stand out against and remove these kind of difficulties, which are to be dealt with through the deepening of the instrumental analysis at all levels. For instance, even without postulating that all species are likely to have a relevant ecological role, it may be argued that it is most difficult to know *a anteriori* which have it or not, or to know when the accumulation of local extinctions in a biological community might lead to an ecological rupture. But how to firmly defend the preservation of a certain endangered species for which no relevant ecological or economic role at all is known, particularly when its preservation conflicts with the viability of developmental projects of unquestionable economic and social value? This is a kind of dilemma that occurs routinely in the governance of human societies.

The main drawback of instrumental valuation lies precisely in the *burden of proof*: if the value of each parcel of biodiversity is to be measured exclusively through its utility for human interests, it is up to those that seek to preserve it to invoke and demonstrate a higher value than that of those economic activities that threaten it. In other words, facing a certain developmental project, conservationists are those who will need to find and prove the allegedly higher value of the "zero option". Worse than that, their task will never be really fulfilled, as the developmental threat may always re-emerge from its ashes in the form of a revised project, more profitable, more popular, more needed for socially supported goals. In general this is the situation that prevails nowadays, except when dealing with a species or ecosystem that is covered by a legislation explicitly inverting the burden of proof, as in the case of the Habitats and Wild Birds Directives of the European Union, and of the Endangered Species Act of the USA. Actually, it is philosophically curious and almost bewildering that societies sharply anthropocentric may adopt this kind of legislation, suggesting an alternative paradigm, from biocentric to ecocentric… But what we should retain from this is that, through the exclusive path of instrumental value, the burden of proof is kept over the shoulders of conservation. Yet, if biodiversity were shown to have some sort of intrinsic value, independent from any use that it may have, then the burden of proof could and should be inverted.

Up to this point we have been referring to instrumental value as it derives from the satisfaction of human interests, and we have concluded that a good deal of moral consideration can be extended to biodiversity under this kind of approach. But if other entities apart from humans were shown to have morally significant interests, then the mantle of indirect moral consideration for the environment and biodiversity might be extended even further. Consider those animals that are shown to have conscious desires (Varner, 1998), the touchstone of morally relevant interests. Or consider sentience, the capacity to suffer, as the threshold for moral consideration (Singer, 1993). Of course, if both human interests and desires plus (some) animal interests or desires are to be considered relevant, and if biodiversity is instrumentally relevant for the fulfilment of these interests and desires, then biodiversity gains greater indirect moral value. This can be taken even further by considering that each and every single living individual, including those devoid of any conscience or sentience, have biological interests deriving from their being a product of a evolutionary history that confers them the interest to live, to fulfil their functions and life cycles, to reproduce (Taylor, 1986; Varner, 1998). For an ethical framework under which interests are the necessary and sufficient condition for some sort of ethical consideration of their beholders, this view would actually reinforce the indirect moral value of biodiversity. Biodiversity is a supra-individual concept, but it is clearly composed by the union of all live forms. As such, to preserve biodiversity is obviously important in order to fulfil the interests of all those individuals that constitute it. These are further indirect extensions of moral consideration to biodiversity that follow the same kind of reasoning of anthropocentrism, but that are biocentric in the sense that all living individuals, both human or non-human, are in the centre of morally relevant value. What they are not, however, are ecocentric foundations of the ethics of biodiversity. Again, if the diversity of life on Earth were to deserve moral consideration in itself, independently of any interest or use by third entities, then it would have to have intrinsic value. But, does biodiversity have intrinsic value?

AN INTRINSIC VALUE?

We have finally reached the central question of *intrinsic value*, that value that would exist beyond any usefulness for an evaluator such as the human being, or beyond any instrumental value for any other entity. If each single biological species or ecosystem were valuable in itself, through some intrinsic or inherent worth that it somehow might have, then that would be intrinsic value as most philosophers conceive it. The question of the intrinsic value of nature, species and biodiversity included, is central in environmental ethics, and is not yet settled. Clearly, if biodiversity has intrinsic value, then whoever proposes to act against it must show that, with his or her projects and goals, a wider good is to be achieved, susceptible to override both the instrumental and the intrinsic value of whatever is at stake. It will no longer be a debate on different visions of what is human interest – we would be a step further in the underlying ethics. But this is a philosophically controversial issue, with some authors maintaining that the whole idea of a value independent of evaluating subjects is a theoretical nonsense, while others do attribute it to nature, wild life or biological variety through different lines of reasoning (Rolston, 1989; Larrère, 1997).

I will not revise here the main aspects of the debate on intrinsic value of environmental entities, as that would bring too far and may be found elsewhere (e.g. Norton, 1987; Agar, 2001). But as I am one of those that intuitively feel that such kind of value does exist, I will rather expose my preferred line of reasoning on where and how the intrinsic value of biodiversity is likely to be found. My contribution to the question of the living world intrinsic value makes reference to the evolution of the Universe. Science has started to give us some fundamental insights on the evolution of all the matter, either living or non-living, that constitutes the cosmos – in other words, of cosmic evolution. We now know that the Universe experiences a *transformational evolution* (Levin, 1999) since its origin from a singularity that we call *Big Bang* and that took place around 15 thousand million years ago. Since then, the Universe has entered into a process of expansion and cooling that goes on and seems to be potentially eternal. The cooling is related to the fundamental law of thermodynamics stating that the overall disorder (entropy) of the Cosmos increases constantly. Yet, we also know that the expansion and the precise characteristics of this Universe generate conditions so that, with the passage of time, matter gets structured into what has been called a "*Pyramid of Complexity*" (Reeves, 1986, 1998), represented in Figure 2.

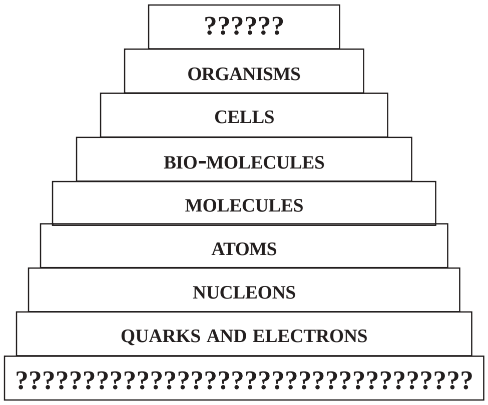

Fig. 2. The Pyramid of Complexity. The organization of matter is achieved through a strategy in which the elements of each layer combine to form the elements of the layer over it. The question marks set the limits of our present knowledge. Astronomy and astrophysics show us that the pyramid did not exist 15 billion years ago, and that it got structured with the passage of time, in parallel with the cooling of the Universe [Adapted from Reeves 1986].

The Pyramid of Complexity illustrates and summarizes what we presently know about the unfolding of the Universe (Swimme and Berry, 1994). We know that in the very first moments there were only subatomic particles or whatever existed before them, and that, with time, cooling and expansion, part of the cosmic matter came to get structured into growing layers of complexity, each arising from the underlying layer: nucleons, atoms, molecules, bio-molecules, cells, living organisms, species, ecosystems… As far as we know, living matter – that is, biodiversity – occupies the highest layer in the Pyramid. If we look into the Pyramid, we can notice that other characteristics increase together with higher complexity, such as: (i) rarity (there are far more atoms than molecules, molecules than bio-molecules, bio-molecules than cells, cells than organisms); (ii) fragility (it is far easier to destroy a cell than a bio-molecule, a bio-molecule than a molecule, a molecule than an atom, an atom than a nucleon…); (iii) and diversity (the diversity of organisms is far greater than that of cells, that of cells than that of bio-molecules, that of bio-molecules than that of molecules, that of molecules than that of atoms, etc.). Life is simply the most fragile, rare, diverse and complex known cosmic entity, in a Universe whose general rule is the overall increase in entropy. To use Holmes Rolston's words, "*Life is a countercurrent to entropy, an energetic fight uphill in a world that overall move thermo-dynamically downhill*" (Rolston, 1994, p.69). The high rank complexity that life represents can only be obtained through many thousands millions of years of cosmic evolution. Life is actually rare enough so that (at least so far) we only know it from this small "islet of complexity" that we call Earth. All this, I believe, should entitle us to attribute intrinsic value to all living entities, including their holistic assemblages.

Of course, I am aware that the invocation of the naturalistic fallacy – no "ought" should be derived from a simple "is", it states – will be watching over this kind of objectively grounded moral claim. Is it fallacious to claim that from the cosmological "*is*" of life's complexity an ethical "*ought*" may be inferred? Perhaps so, but I think this is more question begging than the simple reference to the dogma of the naturalistic fallacy – which is actually open to be questioned in itself (e.g. Rolston, 2001, Arnhart, 1998, p.81-83; Agar, 2001). Furthermore, consider for instance that complexity of the highest known level is an a priori condition for any of the non-religious ethical criteria: interests, desires, sentience, conscience, self-conscience and rationality, are all emergent properties of those special complex adaptive systems that life forms are. Is this not a further reason to attribute moral relevance to complexity, even if indirectly? If, as I intuitively and rationally believe, the characteristics of our Universe are such that we ought to value complexity, then we will eventually find here an objective basis to ground the intrinsic value of living organisms in general, and of those collective entities they constitute in particular. Biodiversity ought to be seen as an evolutionary capital of time and complexity, slowly accumulated in Earth's biosphere during some 4 thousand million years, with which and from which humankind emerged. In this sense, the preservation of biodiversity ought to be seen as one of the main ethical duties of humankind.

Cosmic evolution is an epic narrative that has started to be revealed and told by those fascinating entities through which the Universe reasons about itself – human beings –, and which, I claim, serves to explain, attribute and legitimate the intrinsic value of life, nature, biodiversity. Furthermore, the evolutionary intrinsic value might have the potential to establish hierarchies to be taken into account in practical ethics decision-making. This would require the establishment of those relevant thresholds of complexity among types of living entities. Although the scientific measure of complexity is no simple task (see Lewin, 2001), one might argue that the wolf or the panda are far more complex (as evaluated by their encoding information, or even better, by their capacity of information processing), than, say, any microorganism or nematode. In another way of putting it, given a planet and the vastness of cosmic time, the amount of evolutionary time needed for the emergence of a entity “mammal-like” regarding the level of complexity, would undoubtedly be longer than that for the emergence of entities with a complexity equivalent to that of a microbe or a worm. In the absence of other reasons or criteria, such as those related to the cognitive and mental capacities of organisms, or related to their specific ecological roles, this would be a criterion to justify that the mammal, with other things alike, ought to receive higher ethical and conservationist consideration. From my point of view, complexity should be viewed as a fundamental pillar of livings beings valuation, and should need to be explored, analyzed and dully taken into account together with the other relevant criteria of valuation that underlie ethics.

KEY-WORDS Biodiversity. Ethics. Environment. Cosmic Evolution. Value

ABSTRACT What is there in the diversity of life that is morally relevant? This paper aims at reviewing the main features of biodiversity and its conservation from the standpoint of value and ethics. Biodiversity is framed within conservation biology and environmental ethics. It is claimed here that biodiversity loss is the main problem within the global environmental crisis. Facts and numbers on biodiversity in time and space are analysed in order to highlight what is at stake. Some usual arguments against conservation are critically analysed. The causes and meaning of the biodiversity crisis are put into context. In particular it is shown that the Sixth Great Extinction Spasm is now under way due to human activity, whatever the figures of extinction rates considered. Further, it is shown that there are growing reasons to consider that this extinction spasm started quite early in human history. The value of biodiversity is scrutinised from an ethical standpoint. Starting from an anthropocentric perspective, its wide instrumental value for human purposes is reviewed in its potentialities and limitations. It is argued that biocentric ethics extend the scope of indirect moral significance of biodiversity within the well-established ethical view based on the satisfaction of interests. But biodiversity is a holistic environmental entity, whose eventual direct moral standing will suffer from the same theoretical difficulties that affect ecocentric environmental ethics. Cosmic evolution and the quest for complexity are invoked as the probable key to legitimate the intrinsic value of life, nature and biodiversity.

NOTE

1. This text results from the lecture “Ethics and Biodiversity”, FLAD/NSF Interntional Biocthics Institute, Luso - American Foundation (July 2000, 2001 and 2003). A previous version was published in H.D. Rosa, “Conservacâo da Diodiversiduvle: Significanto, Valoriyagâo e Implicações Eticas”, Revista yuridica de Ordenamento do Territorio e Ambiente, 14: 179-204 (2000).

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