

OPINION N° 125

Biodiversity and Health: a New Relationship Between Humanity and the Living World?

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Abstract

The relationship between human health and biodiversity, the living part of nature, is well documented and complex. While biodiversity is a threat in that it incorporates a reservoir of diseases and vectors, it is also an essential source of active molecules complementing the direct services that ecosystems contribute to the health and wellbeing of humanity. All things considered, biodiversity is a major factor in the health of humanity. And yet, current state of knowledge in the environmental and life sciences emphasises the sometimes dramatic erosion of biodiversity, in particular due to the pressure of anthropic activities, and the new magnitude of human contributions to biodiversity.

In proposing ethical reflection on the relationship between humanity and biodiversity and, more generally with nature, CCNE is first of all mindful that humanity itself is a part of biodiversity. Its position in the midst of biodiversity and its capacity to alter biodiversity for the worse make it necessary to effect a change in the relationship that humanity constructs with the living world. Ethical reflection on the subject therefore resides in an analysis of the consequences of our actions or even, more fundamentally, in an analysis of their causes, that is to say the way we interact with other members of humanity and with all life on earth.

CCNE believes that an ethical course of action in the life and health sciences must include drawing public attention and debate to the causes of the persistence of poverty and hunger in the world and to the increase in relative impoverishment and health issues related to impaired biodiversity, demographic expansion and the escalation of migratory flows. Within the living world, humanity's particular accountability entails an obligation to call into question the concept of progress hitherto equated with increasing control over that world.

This accountability primarily falls upon the scientific community where a more unassuming approach could help to gain a better understanding of the links between biodiversity and health in the context of the inherent unpredictability of interacting dynamic processes, in particular those related to biological evolution.

At a time when genome transforming biotechnologies are increasingly effective and readily implemented, fostering a responsible ethical attitude to scientific and technical activities is an essential priority.

Sharing more effectively the sum of scientific knowledge with political decision-makers and society as a whole, while contributing to the questioning of its applications, is a major ethical challenge.

The protection and use of biodiversity require a somewhat more complex ethical analysis than the sole objective of conservation, all the more so because the degradation of biodiversity must frequently be correlated with the precarious situations in which many human communities find themselves.

An ethical approach and solidarity must be deployed in conjunction if the issue of long-term management of natural resources is to incorporate the prospects for fighting poverty.

The time has come to cast aside the utopia of nature at humanity's disposal and to replace it by a search for the synergies between possible forms of human development allied to recognition for the dynamic processes of ecosystems, both at a local level and through global governance instruments which are yet to be discovered.

This can only happen if people, including the scientific community, are committed to the task of identifying courses of action leading to relevant legislative change.

Based on such ethical reflection, this report seeks to determine the pathways to rational coevolution of humanity and life on earth so as to preserve its potential for wellbeing and health.

Preamble

This report submits an innovative approach to ethical consideration of the relationship between humanity and the living portion of nature: biodiversity (cf. annex 1). It aims to offer a new approach to an issue which, until now, had mainly been considered from a scientific, political or economic viewpoint. It reflects the need for adjusting the relationship between humanity and life on earth. It stresses the concept of safeguarding the capacity of biodiversity to adapt and evolve, rather than that of conservation of the living world. In view of what science has taught us about three and a half billion years and more of evolution, listing the extinction of one species or another is not the most pertinent analytical approach, even though it may affect our sensibilities: species have evolved without cease since time began. Such an approach leads essentially to attitudes of preservation or conservation which need to be debated.

Today's concerns focus more on the speed with which biodiversity is eroding under the pressure of human activity. The essential point at issue would be rather to preserve the capacity of the living world to diversify and renew itself rather than conserving a given state of biodiversity at a given time in the history of humanity. This essential concerns principally our capacity to cohabit harmoniously with all of non-human life².

The rate at which certain species are becoming extinct or the threat to their continued existence are indicative of the damage to the environment that our activities are producing and their impact on human health, the accepted definition of which is currently: *“Health is a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity”*³.

In this context, the fundamental nature of knowledge sharing and its appropriation by society as it goes about its activities now appears as one of the major ethical challenges.

I. Reaffirming humanity's place within the living world

- Intensifying action for the protection of life

For thousands of years, human creativity has tended to promote optimal appropriation of natural resources so as to respond to human needs and has structured the relationship of human societies to the living world and more generally to their environment. Humans thus moved on from an era of predation by societies made up of hunter-gatherers to a phase when they transformed nature and certain species for their own benefit⁴. This social mutation took

² Massive use of antibiotics in industrial animal farming, which stimulates the emergence of multi-resistant bacteria, and vaccination are two different forms of our cohabitation with biodiversity. These two practices, although both are derived from scientific discoveries, have opposite impacts on human health. This example emphasises the need for constant evaluation, including ethical evaluation, of the technical and commercial developments of scientific research and of its repercussions on life's capacity to evolve.

³ Preamble to the Constitution of the World Health Organization, as adopted by the International Health Conference held in New York from 19 June to 22 July 1946, signed on 22 July 1946 by the representatives of 61 States. 1946; (Official Records of the World Health Organization, n° 2, p. 100) and entered into force on 7 April 1948.

⁴ Neolithic is the word generally used to identify this period in time marked by the development of animal farming and agriculture due to the domestication and creation of certain species, the appearance of urbanisation and the development of the fire-based arts and of ceramics (see also Annex 2). However, the sequence is not always identical (the chain of events: agriculture/urbanisation/ceramics is not universal), nor is their chronology which originated in various parts of the planet about ten thousand years ago and then spread for another few

place in the context of domestication and management of natural resources, aiming to control nature by developing cultural and technical practices that each society adapted to its environment. These practices structured contemporary notions of progress, development and health.

It was only from the 18th century onwards that scientific studies of living species led to growing awareness of both their profusion and their fragility. In parallel with the emergence of the concepts of evolution and ecology, the Western world developed approaches to the protection of nature in which anthropocentric ethics stood in opposition to ethics focusing on the living world as a whole⁵.

As pointed out by B. Chevassus-au-Louis and G. Pipien⁶, “...while the description of biodiversity in terms of entities is a legitimate approach [...], an individual from a given species can only exist if, from birth, he can build a multiplicity of relations with other individuals from the same species or other species. The relations will be determinant for the future of that same individual and the role he may have to play in the functioning of ecosystems: biodiversity is first and foremost a question of relations!”

In the aftermath of the Second World War, in reaction to its atrocities, a number of world conferences were held to ensure the reign of peace, justice and equity over our planet. Out of this there emerged in 1945 the United Nations, responsible for the conclusion of economic and political agreements aiming to generate lasting peace in the world, and UNESCO, consecrating the foundation of humanity’s intellectual and moral solidarity. These organisations went on to convene or support a large number of international conferences leading to the adoption of global charters focusing on the financial economy and trade as well as on health and the natural environment⁷.

In their original intent, such charters were to be enforceable against all the States constituting the human world (197 States recognised to date). Today, we can only acknowledge that respect for biodiversity on an international scale is compromised by failure to meet these obligations by a large number of countries, including the most powerful, in terms of industrialisation and in the context of deteriorating international relations. It must be stressed that the stability of international relations, in particular as regards trustworthiness in the

thousand years via a “neolithisation” process which continues up to the present time and moderates the pertinence of the term Anthropocene for recent times.

5 The “Conservation” movement proposes a strictly anthropocentric ethic, one of its initiators being the forestry expert Gifford Pinchot (1865-1946), adviser to Theodore Roosevelt. The “Preservation” current, proposing an ethic anticipating the ecocentric movement, was initiated by, among others, the American naturalist John Muir (1838-1914).

6 Chevassus-au-Louis B. and Pipien G. (2014). La biodiversité, du « grand inventaire » à la « toile du vivant ». *Humanité et biodiversité* n°1, 15-24.

7 An international conference held in Fontainebleau, in the autumn months of 1948, led to the creation of the International Union for the Protection of Nature (later changed to IUCN, International Union for the Conservation of Nature) with the object of the “*preservation of the entire world biotic community, or man’s natural environment, which includes the earth’s renewable natural resources of which it is composed, and on which rests the foundation of human civilization [...] protection of soils, water, forests, wild life and wilderness areas [which] are of vital importance for economic, social, educational and cultural reasons*”. The conference also found that “...the time has come when human standards of living are being depressed because natural resources are becoming inadequate for their maintenance...” and that “...this trend may be reversed if people are awakened in time to a full realization of their dependence upon exhaustible natural resources and recognize the need for their protection and restoration as well as for their wise and informed administration in order that the future peace, progress and prosperity of mankind may be assured”.

implementation of treaties and climate commitments, the peaceful settlement of disputes, the quality of internal legislation and of legal infrastructures in each country constitute a preliminary to any effective ethical consideration of biodiversity by the whole of humanity.

- Considering humanity's responsibility in the living world

While plundering of natural resources has been an essential factor in the survival of the species since the dawn of humanity, it assumes a new dimension in this time of explosive demographic expansion. It is only recently that humanity's geographic and demographic expansion has required us to consider the planet in its totality and the limits of its natural resources.

In this context, the current state of knowledge in the life, environment and health sciences highlights the dramatic nature of the threat to natural resources. Also current knowledge is the impact of human activity on biodiversity resilience and its deleterious consequences on human health, which are particularly critical for underprivileged members of the population. At a time when the links between health and nature are increasingly well established, it would seem appropriate, in parallel with research on environmental impacts, to make a special effort to discover how the disruption to biodiversity caused by human societies has direct or indirect repercussions on health.

Does the essence of ethical reflection reside, as is often the case, in an analysis of the consequences of our actions, or more fundamentally in an analysis of their causes, that is the modalities of our interaction with other members of the human species and with the living world? In CCNE's view, the life and health sciences' ethical approach must focus on bringing to public attention and debate the questions that must be asked on the causes for the persistence of global poverty and hunger, for the increase in relative impoverishment of various human communities as it relates to diminished biodiversity and to demographic issues. In this respect, hunger and malnutrition which are relatively stable on a planetary scale, may affect new countries while others manage to overcome this handicap. Furthermore, some countries are confronted with an increase in their relative impoverishment because of a dramatic population growth which may itself be connected to the spreading erosion of their natural environment.

These ethical considerations also call into question the centuries-long ambition to control the living world which, it is true, does lead to a form of progress consisting of considerable advances in terms of development and health, but also to a form of relationship with nature which to some extent disturbs and endangers it. It is on the basis of such considerations that this report seeks to identify the paths to humanity's reasoned coevolution with the living world as a whole, the better to preserve its potential for wellbeing⁸.

⁸ This report puts forward the reasons justifying the urgent need for a change in the relationship between human societies and the living world with a view to humanity's development in the light of current knowledge of the dynamics of the living world. WHO's definition of health should therefore evolve to take into account the terms of the Preamble to the Aarhus Convention (1998): "*Recognizing that adequate protection of the environment is essential to human wellbeing and the enjoyment of basic human rights, including the right to life itself; recognizing also that every person has the right to live in an environment adequate to his or her health and wellbeing, and the duty, both individually and in association with others, to protect and improve the environment for the benefit of present and future generations.*"

Increasingly, with scientific progress comes awareness of the complexity and the dynamic interaction characteristic of the living world, and the extent to which all individuals, including humans, constitute within species a dynamic ecosystem related to the entire biosphere.

- Calling into question the notion of progress

Today, humanity's negative impacts on the diversity of the living world are fully documented⁹. They call into question the ethical dimension of the human position amid the natural environment. The same is true as regards human responsibility for phenomena which, over and above a loss in biodiversity, modify the dynamics of material cycles¹⁰ as well as the global climate, even as they compromise the health, and therefore the wellbeing, of human populations.

Because scientific knowledge developed in a cultural context based on control of the living world, it has focused primarily on research responding to expectations as regards health, agriculture and animal farming, rather than on research seeking to analyse the particular dynamics of biodiversity. Such scientific knowledge has also given us a better understanding of biodiversity's vast dimensions and provided the means to analyse its dynamics, thus evidencing the threat posed by certain human activities even though such activities also contribute at times to biodiversity through the creation of a considerable number of animal or plant species. If aspirations for improving the conditions in which humanity lives are to be fulfilled, gaining a better understanding of these dynamics, of the processes which preside over the existence or disappearance of ecosystemic services and resources as well as the reasons for the emergence of epidemics, is essential. This pursuit of greater understanding is all the more pressing since human activity is more often than not the cause of the disturbances that have a particular impact on the survival of the most vulnerable populations.

The issues of biodiversity erosion and of damage to ecosystemic services are even more dramatic today in the context of explosive global demographic expansion — on the African continent particularly — and of the increasing vulnerability of a part of the expanding population. Nearly a billion people suffer from malnutrition and lack of adequate access to safe drinking water; one child in twelve dies before the age of five in sub-Saharan Africa. The ecological crisis is also a social crisis with an impact, first and foremost, on the most deprived.

**The notion of progress, until now synonymous with greater control over the living world¹¹, needs to be challenged, replacing this pursuit of control with new concepts:
- The relationship between humanity and the living world must fully take into account that humanity is a part of the living world and that therefore its development cannot take place at the expense of environmental damage that could compromise the capacity of ecosystems and species to adapt and evolve.**

⁹ <http://uicn.fr/liste-rouge-mondiale/>

Rocström J. *et al.* (2009). A safe operating space for humanity. *Nature*, 461, 472-475. (cf. annexe 1).

¹⁰ In particular the biogeochemical cycles of nitrogen, carbon and phosphorus.

¹¹ Integration of the "precautionary principle" and later of "environmental mitigation" concepts is not, in practice, exempt from the general context based on the capacity to control the natural environment. The implementation of these concepts often neglects to take account of the dynamics of natural processes and of the value in the medium and long term of a coevolutionary approach with a view to limiting deleterious effects on such processes.

- Humanity's development must give priority to the concept of coevolution with the living world.

The coevolution concept must take into consideration the regional and planetary dimensions of the adaptive and evolutionary processes. In this connection, the endangered situation of certain populations, generally the poorest, bears witness to the disruptions, some of them new, in "man-nature" relations, including the emergence of epidemic diseases.

II. Greater ethical accountability for the scientific community

The concept of biodiversity's dynamic equilibrium¹² speaks in favour of adding a supervisory dimension and an ability to monitor new phenomena, in a context where unpredictability is no longer perceived as being exclusively the result of a limited level of knowledge. Biodiversity should be considered as being one of the components of the dynamics involved and can be related to both the date and the magnitude of a natural occurrence as well as to the medium and long term effects of a given planning or health care¹³ measure being adopted.

- Unpredictability of biodiversity and health systems

Since the 18th century, the scientific community has been viewed as a breeding ground for warnings regarding the fragility of the living world (Annexes 2 and 3) and as the source of fears that scientific progress might be called into question. In 1992, just before the Rio Summit, several hundred scientists launched the Heidelberg Appeal decrying "*the emergence of an irrational ideology which is opposed to scientific and industrial progress*". They then left aside scientific and prospective analysis to continue with the statement that "*humanity has always progressed by increasingly harnessing nature to its needs*"¹⁴. A similar outlook is still being expressed by sceptics questioning the reality of climate disruption and losses of biodiversity.

Far from this form of scientific arrogance, this report seeks to emphasise the extent to which the expansion of scientific knowledge, in particular an awareness of changes of scale, is still a major objective in achieving greater understanding of the links between biodiversity and health with a view to the coevolution of humanity within the living world. In parallel, research responding to the legitimate need for medical care and for increasing the production of food resources, must also seek for better understanding of the capacities of systems and species for regeneration, resilience and adaptation, so as to aim for synergy between humanity's development and the evolution of life on earth.

However, the concept of synergy goes further than just the 'precautionary principle'. It leads to a redefinition of "ecological compensation" and calls into question the legitimacy of the purely financial compensation which is generally adopted for this purpose, and which is of a different order from the phenomena of evolution and adaptation of the living world.

In the same spirit, in the event of a request for expert appraisal, the absence of scientific certainty does not remove the need, when there is reasonable doubt, for an ethical analysis putting into perspective the unpredictability of systems as regards biodiversity and health. In contrast to prevailing international agreements, business interests should not play a preponderant role as is all too often the case¹⁵.

12 Equilibrium is in a constant state of renewal, therefore the challenge cannot be limited to creating a replica of ecosystems of past centuries, or even to conceiving a static edition of biodiversity, frozen in time.

13 In fact, it took several decades to realise that certain urban revegetation programmes (which increased contact between species carrying allergenic pollen and population concentrations) had to be cleared to make way for a selection of plants which could adapt to an urban environment and to which, moreover, human societies were better able to adapt.

14 Shortly thereafter, the Philip Morris company stated that it was pleased to have made a contribution to the appeal together with some members of the asbestos industry.

http://www.lemonde.fr/sciences/article/2012/06/16/l-appel-d-heidelberg-une-initiative-fumeuse_1719614_1650684.html

15 The General Agreement on Tariffs and Trade (GATT) and the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) allows States to take measures "necessary for the protection of human

The unpredictability of evolutionary phenomena is a structural component of the constantly active natural dynamic processes. The objective, therefore, is no longer the conservation of supposedly stable ecological systems, but rather to ensure that their capacity to evolve, to adapt and to recover remains intact and, whatever the circumstances, to try and curb any action whose consequences could have a negative effect on these processes¹⁶.

Contemporary ethical views of nature must henceforth consider and supersede earlier concepts where there was opposition between ethical approaches embracing the living world as a whole and ethical approaches granting preponderance to a given human society or even based on the services that nature could provide for humanity.

The challenge no longer resides in an analysis of environmental policies in terms of the protection of existing species, but in whether such policies have the ability to safeguard the evolutionary potentials of species and ecosystems.

Advances in scientific understanding bring to the fore that the kind of unpredictability which is inherent to interactive dynamic processes is different from unpredictability that is the result of a limited level of knowledge. This new scientific awareness implies that there is a requirement for ethical reflection on health and the environment to be associated to any measures for the exploitation of natural resources on the one hand and their protection via possible compensation on the other.

- Encouraging the sharing of recent knowledge

In 2005, the Millennium Ecosystem Assessment (MEA) requested by the United Nations indicated in its conclusions for the attention of decision makers that so-called ecosystemic services rendered to humanity by nature and particularly by nature's biodiversity were degraded: *"Approximately 60% (15 out of 24) of the ecosystem services evaluated in this assessment (including 70% of regulating and cultural services) are being degraded or used unsustainably. Ecosystem services that have been degraded over the past 50 years include capture fisheries, water supply, waste treatment and detoxification, water purification, natural hazard protection, regulation of air quality, regulation of regional and local climate, regulation of erosion, spiritual fulfillment, and aesthetic enjoyment."*

Since that time, ecosystem services rendered specifically by pollinating insects were found to be not only essential to the quality and yield of three quarters of the world's food crops, but also threatened by biodiversity erosion in honey bees, among other pollinating insects, in the northern hemisphere. In this context, IPBES¹⁷ has recently published its first assessment report of ecosystem services rendered by pollinating insects. While the report does not validate the finding of a general decline in the 20,000 species of bees, it does note a decline in

and animal life or health". However, all protective measures require the production of scientific evidence to demonstrate that they are not "disguised restriction on international trade" (GATT, Article XX) which led, for example, to condemnation of the European Union when it banned the import of beef containing growth hormones for lack of what was deemed to be adequate scientific evidence.

¹⁶ See, for example, the assessment made by Barnovsky A.D. *et al.* (2012). Approaching a state shift in Earth's biosphere. *Nature*, 486, 52-58.

"Localized ecological systems are known to shift abruptly and irreversibly from one state to another when they are forced across critical thresholds. The plausibility of a planetary-scale 'tipping point' highlights the need to improve biological forecasting by detecting early warning signs of critical transitions on global as well as local scales, and by detecting feedbacks that promote such transitions."

¹⁷ *The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.*

countries where surveys were made and recommends global monitoring¹⁸. The high media profile given to global warming sometimes gives rise to an initial impression that it is directly to blame for diversity erosion. The scientific community should contribute to the understanding that the phenomenon is rather more complex, although it does pose some converging global governance issues¹⁹. This was also the message conveyed by CCNE's statement just before COP 21²⁰.

Humanity's deleterious impact on the diversity of species is in fact far more ancient than any global anthropogenic climate change. The disappearance of some animal populations, and even the total extinction of certain species, in geographical areas that came to be populated by humans have been documented since prehistoric times²¹. Today, while biodiversity erosion is due partly to climate change, in many cases it is the direct consequence of exploitation (overfishing, logging) or of development (deforestation for urban and agricultural conversion, etc.) and of the use of a vast number of molecules interfering with vital processes, either deliberately (herbicides, antibiotics, etc.) or accidentally (nitrates, phosphates, endocrine disrupters, etc.) due to their accumulation in environments or trophic chains.

Conversely, loss of biodiversity may aggravate climate change. Uncontrolled deforestation truncates the capacity of natural forests to capture and fix huge quantities of CO₂. In parallel, marine phytoplankton disruption truncates, to a certain degree at least, carbon sequestration. In some cases, reef ecosystems for example, the consequences of warming and direct negative effects on species combine, jeopardising a number of human settlements and societies in the short and the medium term²².

- Ethical issues arising out of modifications to the living world

Ethical reflection on the development of biotechnologies

When Joseph Fletcher remarked that nature is first of all a source of hazards, risks and disorder and that it must be domesticated, dominated, replaced if possible by a rational order

18 "Wild pollinators have declined in occurrence and diversity (and abundance for certain species) at local and regional levels in north west Europe and North America. Although a lack of wild pollinator data (species identity, distribution and abundance) for Latin America, Africa, Asia and Oceania precludes any general statement on their regional status, local declines have been recorded. Long-term international or national monitoring of both pollinators and pollination is urgently required to provide information on status and trends for most species and most parts of the world." IPBES (2016): Summary for policymakers of the assessment report of the Intergovernmental Science-policy Platform on Biodiversity and Ecosystem Services on Pollinators, Pollination and Food Production. S. G. Potts, V. L. Imperatriz-Fonseca, H. T. Ngo, J. C. Biesmeijer, T. D. Breeze, L. V. Dicks, L. A. Garibaldi, R. Hill, J. Settele, A. J. Vanbergen, M. A. Aizen, S. A. Cunningham, C. Eardley, B. M. Freitas, N. Gallai, P. G. Kevan, A. Kovács-Hostyánszki, P. K. Kwapong, J. Li, X. Li, D. J. Martins, G. Nates-Parra, J. S. Pettis and (directed by) B. F. Viana 36p.

19 The Intergovernmental Panel on Climate Change (IPCC), was set up in 1988 in part because of uncertainty regarding the reality of the anthropogenic origins of climate change, although this is now an established fact. In contrast, humanity's impact on biodiversity has been known for a long time. The adoption of the Convention on Biological Diversity in 1992 and of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) sought to strengthen the link between science and decision-making as regards the preservation of biodiversity and participates in the international governance action to protect biodiversity.

20 http://www.ccne-ethique.fr/sites/default/files/publications/texte_ccne-cop21-6_Novembre_2015.pdf

21 Hunting the megafauna had certain repercussions on biodiversity in the early Holocene; when the first humans settled in Australia, some marsupials became extinct and, in America, mammoths died out.

22 "L'homme dévore 1,5 Terre par an" was the title of an article in "Le Monde" on 1st October 2014, referring to the loss of half of wild species populations, to the depletion of resource stocks and the accumulation of waste. http://www.lemonde.fr/planete/article/2014/09/30/la-terre-a-perdu-la-moitie-de-ses-populations-d-especes-sauvages-en-quarante-ans_4496200_3244.html

of the world eradicating uncertainty and unpredictability²³, he was perpetuating the illusion that we can master and control nature. This over-reaching ambition relies on a simplistic vision of the genome as being a juxtaposition of genes, to be classified as “normal” or “abnormal” once it becomes technically possible to correct nature’s alleged mistakes.

We make considerable modifications to biodiversity indirectly, but we are also capable of making substantial intentional modifications to the living world. The transfers and domestication of species which marked the early Neolithic Era are now vastly multiplied by biotechnologies facilitating cloning, the assembly of new genomes and the creation of genetically modified organisms and other procedures.

The convergence of key scientific domains (biology, information technology, chemistry, etc.) has paved the way for the emergence of disruptive technologies leading to innovation in a context of relative unpredictability due to the state of scientific knowledge and to the previously mentioned unpredictability of evolutionary processes. In these circumstances, it is essential that researchers and engineers operate very transparently and provide critical assessment of their methods and goals, so that their ongoing research can be clearly understood.

One ethical dimension that needs emphasising is that it is necessary to contribute with humility to the production of new scientific knowledge and innovation, the usefulness of which must be made known to society and remain open to society’s investigation. It is also necessary to refrain from bolstering a showcase of promises adding fuel to a collective imagination of expectations that ignore the complexity of the living world²⁴.

Cross-breeding, hybridisation, cuttings and selection to obtain selected animal and plant varieties have been in use since time immemorial to fashion the living world in a form that would achieve particular human projects. Back in the 1970s, genetic engineering techniques began to make far-reaching changes to agronomy (genetically modified plants and animals) and to medicine (gene and cell therapy). With DNA sequencing techniques it has become possible to think in terms of true genome engineering and CRISPR-Cas9 is a new step in this direction since the “genome surgery” it enables is much easier and more precise than was previously possible, in both technical and economic terms²⁵.

CCNE initiated ethical reflection on modern genome engineering techniques, CRISPR-Cas9 in particular, with respect to human applications. For the purpose of this current report, two of their main characteristics should be subject to particular scrutiny, besides their applicability to the living world as a whole and the issues they raise in terms of the irreversibility of genetic modifications introduced voluntarily into organisms since, voluntarily or otherwise, these modifications will inevitably spread beyond their initial boundaries.

23 Fletcher J.F. (1974). *The Ethics of Genetic Control: Ending Reproductive Roulette*. Garden City, N.Y. Anchor Press, 218 p.

24 Opinion of the Joint Consultative Committee on Ethics in Agricultural Research (2013) : <https://inra-dam-front-resources-cdn.brainsonic.com/ressources/afile/248827-0c75b-resource-5e-avis-du-comite-d-ethique-inra-cirad-36-pages.html>

25 The CRISPR-Cas9 genome editing technique applied to mammalian cells was first developed in 2012 by several research teams, including the Boston Broad Institute researchers, in particular Feng Zhang and George Church, as well as Jennifer Doudna at UC Berkeley and Emmanuelle Charpentier in Berlin.

INSERM’s Ethics Committee emphasised in February 2016 that the main risk inherent in the application of these techniques was an impact on biodiversity (<https://www.inserm.fr/qu-est-ce-que-l-inserm/l-ethique-a-l-inserm/saisines-et-notes-du-comite-d-ethique>).

The first characteristic is that it is possible to modify genetic sequences without leaving any evidence other than the mutation itself. If this mutation already exists in nature, the organisms carrying it will not, *a priori*, be recognisable as being “natural” or “man-made”. The second is that, with these techniques, it is possible to implement a “gene drive” so that the classic Mendelian laws (and others) of trait transmission are bypassed and a genetic disruption may swiftly become invasive in living species. Using CRISPR-Cas9, an American company has been successful in making a mosquito unable to transmit malaria. It intends to release it into the environment so that it can transmit its malaria-resistant gene to the whole mosquito population. Other companies are thinking in terms of simply eradicating genetically several species of mosquito acting as vectors of human diseases. It could be pointed out, however, that malaria’s incidence has decreased over the last decade as a result of urban and rural planning — draining ponds for instance — and educational measures, whereas the possible impact both immediately and in the future of these biotechnologies remains to be explored.

In this context, gene drive was discussed at the Global Biodiversity Summit Conference of the Parties in Cancun in December 2016. As regards applications to the natural environment, 160 NGOs pointed out the risks associated with action to destroy and/or modify so-called “pest” populations or species in the wild²⁶. The ethical tension between the emergence of these scientific advances, the social expectations for human health they give rise to and the limited data available as regards short and long term consequences of “field trial” releases of species born of technology, demonstrates how vital is the need for supporting fundamental research. This has led to a statement from 32 international research or research-financing institutions defining the rules of good practice for research on “gene drive”. These include public involvement at the design phase of such research (Washington, March 2017).

Can the living world be modified without interfering with the process of evolution?

Three components stand out as participating in the now universally recognised exceptional (biological) complexity of life.

The first of these is related to the necessity for any new function that may at some point be introduced into the evolutionary process, to be compatible with already existing functions, particularly those that are consistent with life and reproduction.

The second is related to the subtle and fragile equilibrium that prevails in the regulation of living systems. A number of pathologies are there to remind us that shifting some of this biological balance may have dire consequences, in particular for health. This equilibrium is essential so that living beings can adapt to the complex and dynamic environments in which they exist.

The third is chance, the reason for taking account of the partly stochastic characteristics of gene expression, the very expression we want to control and modify to a tailor-made solution. It is difficult for us to integrate chance and probability into our understanding of the living world and even more so to be subject to them, including in our daily lives.

These three components must be seen against the perspective of over three and a half billion years of the evolution of life on earth, and therefore in a timescale far beyond anything that the mind can reasonably comprehend.

As we see that, biologically speaking, normality is not stable and that evolution uses “evolutionary leaps”, corresponding to highly improbable events, reflection at this level must

26 The Bill and Melinda Gates Foundation invested \$75 million in CRISPR-Cas9 technology to accelerate the development of genetically modified *Anopheles* mosquitoes (mosquitoes acting as vectors for malaria) to resist *Plasmodium Falciparum*, a parasite transmitting malaria.

take into account an essential dimension, that of time, the difference in the timescale of a human life, or even of humanity, and the timescale of nature being totally beyond comparison, perhaps even inconceivable. Seen from a human perspective, evolution has never “hesitated” to eradicate certain forms of life, whole species even, that it had once created, as the various surges of massive extinction attest. While such events have never come close to eradicating life on earth, they have weighed very heavily on its history and, among other things, on the emergence of our species. Today, at a time when biotechnological potentialities appear to be capable of disrupting the balance that the human species has known since its emergence, unprecedented ethical tensions are dawning.

What ethics of accountability do we mobilise today and on what scale, at a time when genome transformation technologies are ever more effective and easy to implement? For the sake of future generations we must fully engage with the ethical challenge of maintaining biodiversity, including in terms of biological evolution potential²⁷. There must be a considerable increase throughout society in the sharing of newly acquired knowledge and in debate on its applications.

III. Health and biodiversity²⁸

The relationship between human health and biodiversity is, generally speaking, a complex one, as illustrated by a number of well-known examples.

-Towards an ecosystemic approach to health

As early as the 1950s, leprosy and tuberculosis were for the major part contained by the use of relatively specific antibiotics, which contributed to the stamping out of these two scourges in the western world. However, twenty years earlier, constructing social housing fitted with sanitation and sufficiently large rooms with enough ventilation provided by reasonably sized windows, had already done more for the regression of tuberculosis than the appearance of the specific antibiotics.

In terms of disease, biodiversity is both a threat and protection for human health. A threat if you consider the reservoir of diseases and vectors it represents, and a protection because of the natural competition between vectors with different transfer capacities, which could create dilution effects limiting the size of the species populations capable of transmitting the infectious agent most efficiently²⁹. But at the same time, it does great service to the production of medications since the synthesis of active natural substances selected through

²⁷ When certain groups are globally threatened, evolutionary potentialities may be severely disrupted, as is the case today for major monophyletic groups such as birds or selaciens, because the number of individuals and of species is collapsing.

²⁸ “*Les liens entre santé et biodiversité*” (The links between health and biodiversity”) were the subject of a report by the *Conseil général de l’environnement et du développement durable (CGEDD)*, at the request of the Minister for Ecology, Sustainable Development and Energy (MEDDE) on 18 November 2011. The report (83 p.) was submitted in April 2013 (n° 008095-01. cgedd.documentation.developpement-durable.gouv.fr/.../008095-01_rapport.pdf). Authors: Eric Fouquet, Patrick Lavarde and Philippe Maler.

²⁹ Conversely, biodiversity erosion increases disease transmission to humans (Keesing F. *et al.* (2010). Impacts of biodiversity on the emergence and transmission of infectious diseases. *Nature*, 468, 647-652).

evolution, in a context of competition between species, is an essential source of active molecules.

WHO considers that 80% of the world's population depends on traditional remedies drawn from wild species. As for pharmacological research, although it has explored only 2% of the world's vegetation and an even smaller fraction of fungi and marine organisms, this is where its major reservoir of new molecules is to be found.

In more global terms, ecosystem diversity contributes to people's personal identity building, to relaxation, individual and collective emotions and their contemplative dimension. It also contributes to personal wellbeing and fulfilment, two essential components of human health. Preserving biodiversity is a health issue that extends well beyond the direct services that ecosystems contribute to human health or the certainty of providing a source of future curative molecules.

This being a brand-new challenge, a number of major ethical issues arise requiring further definition:

- we apply pressures that could be detrimental to biodiversity by upsetting the equilibrium of ecosystems, including certain medical and veterinary practices and certain methods used to combat species classified as harmful³⁰ ;
- our own societies gain from biodiversity, but how can we make sure that such advantages are obtained without detriment to other human societies?

Neither pollution nor disease affects all populations in the same way. WHO states that air pollution alone is the cause of eight million premature deaths every year worldwide. Half of these deaths are connected to pollution from outside air and the other half, mainly in poor countries, is caused by pollution inside dwellings due to domestic use of fossil energies. Similarly, while infectious diseases cause 14 million deaths per year, 90% of this mortality concerns developing countries.

- Issues arising out of interaction between biodiversity and health

It is only recently that public policies have begun to integrate issues connected to interaction between health and biodiversity³¹ and it was as recently as the mid 2000s that several organisations concerned with health and biodiversity mobilised their efforts on an international scale. In 2010, WHO, FAO and OIE declared that it was desirable to achieve “*A world capable of preventing, detecting, containing, eliminating, and responding to animal and public health risks attributable to zoonosis and animal diseases with an impact on food sanitation security*”. The same approach was developed at the Rio+20 conference in June

³⁰ Without revisiting the imbalance induced by inappropriate usage of antibiotics, we could quote the example of experimental anti-mosquito campaigns carried out in the Camargue region of France in 2006, by spreading bacteria harmful to larvae which, after five years, resulted in negative impacts on wildlife. Apart from the resulting biodiversity loss among dragonflies, passerines, swallows and more, these impacts may well increase risks to health. This is so because although the coexistence of forty odd species of mosquitoes limits the risk of a proliferation of exotic species acting as disease vectors, conversely the reduction in numbers of indigenous species may, following the treatment, favour the settlement of new species which could be vectors for emerging exotic diseases and resistant forms, ultimately making it impossible to resort to this bacterial anti-mosquito method in the event of a health crisis at a later date.

³¹ See the national health-environment plan (PNSE 3 for the 2015-2019 time period).

2012. A joint report by the World Health Organization (WHO) and the secretariat of the Convention on Biological Diversity (CBD) not only states that there are links between health and biodiversity, but also underlines the need for more integrated policies. These initiatives are part of the “One Health³²” concept which aims at an integrated approach for all aspects of human health, animal health and the management of ecosystems. This “One Health” concept points out in clear terms the need for policies integrating human health and biodiversity.

Impact of animal health on human health

There does indeed appear to be a close link between human health and animal health³³. Despite some success fighting tuberculosis, as mentioned above, or with brucellosis, the zoonoses³⁴ transmissible to humans are still very numerous. They include AIDS, bovine spongiform encephalopathy, severe acute respiratory syndrome, avian influenza, chikungunya, West Nile virus, etc.

The increase in the number of emergent human diseases in the last fifteen years is often explained as being due to intensive forms of animal farming (with the animal being the origin of the epidemic or the transmission vector), as diminished biodiversity favours disease vectors, as well as to degraded environmental conditions connected, more or less directly, to anthropogenic actions. Such actions may combine with vector transfers ensuing from globalisation of trade, and also to the exploitation of new natural environments creating or increasing contacts between populations and wild species carrying transmissible diseases.

As regards human health, it would be pertinent also to examine relations between human populations and their microbiota since all human beings host in their digestive tract ten times more commensal microorganisms than human cells. Recent research has demonstrated the importance of these microorganisms for each individual’s health and yet over half of them have not yet been specifically identified!

In this connection, inappropriate or excessive use of antibiotics in human and animal health care can create imbalance in environmental bacterial ecosystems, in particular the human intestinal microbiota. This inappropriate use of antibiotics reduces the evolutionary capacities of the living world and is the source of the rapid growth of resistance to currently available antibiotics, which is harmful now and will continue to be harmful in the future. The debate that is urgently needed should discuss how it came about that such a paradoxical situation has been allowed to develop. It is a crucial reminder of the need to replace the ambition to control life on earth with the concepts of coadaptation and coevolution between humanity and the living world.

³² Recent health crises are clear evidence of the increasing globalisation of risks to health and of the importance of the human-animal-ecosystem interface in the evolution and emergence of pathogens. So as to overcome the limits of the conventional approaches to infectious disease, a new concept has been developed, called “One Health” which aims to reinforce links between human health, animal health and management of the environment. This new approach to health, based on intersectoral and interdisciplinary cooperation, is encouraged by the French Government.

See: http://www.diplomatie.gouv.fr/fr/IMG/pdf/Rapport_One_Health.pdf.

³³ To be noted also is that deforestation, for instance, is accelerating the malaria epidemic in Asia, transmitted from monkeys to humans by mosquitoes.

³⁴ Some zoonoses are transmitted via contaminated food or drink and others by vectors, the environment or through contact.

Interaction between pathogens and those who are sick is based on an obvious fact that is sometimes forgotten and that Claude Combes³⁵ calls to mind: “...it is a fact that all living beings are related, as evidenced by the universality of the genetic code and the similarities of metabolic functions or of biophysical processes. Signals can therefore be exchanged between organisms whose common ancestor existed several billion years ago. The pathogen can therefore use and manipulate the biochemical processes of its host for its own benefit. What changed along the evolutionary road is the complexity of organisms but not the foundations of the way they function and, above all, not the nature of molecular signals. Reflection on the evolution of complexity shows the degree to which pathogens, including those which appear to be the most simple, are at a level of complexity that is dangerously close to human complexity.”

The challenge that infectious diseases now present is not limited to certain areas or populations of the world. It is the result of the confrontation between humanity and the unpredictability which is characteristic of the biological evolution of the living world. This lack of predictability is the reason why scientific advances in this field must never be tainted with arrogance, nor excessive optimism, in particular as regards possible capacity to respond to a new epidemic phenomenon!

Apart from the health issues mentioned above, modifications to the environment, including those aiming to create wellbeing or to achieve ecological objectives, may sometimes, when there is a failure to adopt a global approach or to fully integrate the diversity of interactions, have a negative impact. This was the case for the non-integrated development of parks in cities which contributed to the development of allergies to the pollens involved, although the initial intention was to enhance the wellbeing of urban populations. More globally, impacts on biodiversity, such as the decline of pollinating insects we have spoken of previously, or the increase of invasive species connected to the globalisation of trade, modify the living conditions of certain species by reducing their access to food resources.

Preventing the effects of interaction

In terms of impact on human health, preserving biodiversity is imperative: to be “in good health” is not just the result of the medical advances that have made such a considerable contribution to increasing life expectancy. The expectancy of health is also related to the pleasure of observing life and experiencing a sense of belonging to the living world, whether that sense encompasses nature as a whole, taking into account biodiversity and the dynamics of biodiversity, or whether it attaches more importance to respect for wild flora and fauna, or even domesticated species.

This ecosystemic approach to human health, incorporating knowledge of the living world, is an invitation to promote a better understanding of the mechanisms underlying interaction between all the constituents of biodiversity, so that innovative preventive measures can be developed, following the examples already set in the prevention of various pathologies (e.g. cardio-vascular pathologies and obesity).

³⁵ Combes C. (2006). *Pourquoi il y aura toujours des maladies infectieuses*. (Why there will always be infectious diseases) In *La maîtrise des maladies infectieuses. Un défi de santé publique, une ambition médico-scientifique* (G. Orth, P. Sansonetti, coord.). *Rapport sur la science et la technologie n° 24. Académie des sciences, EDP-Sciences, p. 89-99.*

Human beings live in a complex ecosystem where each individual is a distinct ecosystem. This recent scientific line of investigation requires an entirely new approach to human health, on a multi-dimensional, interdisciplinary, holistic level, integrating the concepts of biodiversity and biological evolution. The quality of biodiversity has an effect on human health: preservation of the one is preservation of the other. Based on this analysis, CCNE calls for a consolidation of WHO's definition of health with the inclusion of its environmental dimension.

IV. Towards responsible ecological solidarity

- Protecting biodiversity: rule of law and value

Set as rules of law, the protection of biodiversity becomes a major challenge, because of its ecosystemic, dynamic and global nature. Very diverse spatial and temporal scales need to be taken into account while ecosystems themselves vary with the passing of time.

Legal protection for biodiversity

Generally speaking, the low level of recognition of a legal status specific to natural resources is a handicap to the environment's rightful position within the body of normative instruments. Laws are more or less effective depending on the status they are granted in the hierarchy of interests protected by law (private property; patents on living organisms, etc.). Sometimes, damage to biodiversity is due to diffuse pollutions, the sources of which are difficult to identify and to separate one from another, as in the case of agricultural activities.

In the context of the Natura 2000 project (12.4% of French land) sites are managed locally, giving rise to a medley of local institutional arrangements, concerned in particular with the numerous conflicts they have generated. Controversy arises mainly from the consequences of this or the other action in an environment, frequently unpredictable beyond a certain period of time. Moreover, the fact that policy-makers proceed by picking and choosing between different aspects of biodiversity, depending on the various ways in which resources and space can be put to use to serve various interests, adds fuel to controversy, particularly in a context where scientific knowledge is fragmentary³⁶.

The value of ecosystems

Another approach focusing on the value of ecosystems³⁷ is currently gaining importance, based on a quantification of the costs associated with the destruction of biodiversity and the benefits associated with its preservation. The lawsuit which followed on the oil spill caused by the *Erika* shipwreck rests on the evaluation of the ecological prejudice suffered by local authorities and by those making a living from the sea or coastal tourism.

Attributing a value to biodiversity³⁸ is lodged in a utilitarian logic which is not only a short term computation since there is recognition of utility for future generations. The process does, however, still depend on the possibility of demonstrating the utility of these services and

³⁶ To which must be added conflict between different uses of space: sheep raising *versus* bears or wolves!

³⁷ This is the international exercise under the aegis of the UN in the *Millennium Ecosystem Assessment* (cf. page 10) based on the description of services rendered by the major planetary ecosystems.

³⁸ In concrete terms, the environmental liability system makes it possible to compel the author of damage to biodiversity to repair it, or even anticipate it by compensation mechanisms based on the principle of ecological equivalence.

of choosing between various kinds of usefulness, in particular when there is competition between human production and biodiversity.

Evaluating the economic value of biodiversity (the value of direct, indirect or of “non” use) is just as complex a task as defining the value of biodiversity. This economic approach is often the source of dispute since it injects the social value of biodiversity into merchant mechanisms, but it is a step in the qualification of biodiversity as a “common good”, and may make a significant contribution to decisions such as those regarding equitable access.

In his address to COP 21 on 30 November 2015, President François Hollande said: *“We can no longer consider nature as a mere bottomless reservoir of resources available for our sole and complete benefit. This transformation is both a moral obligation and a global opportunity, for it opens up possibilities for development with renewable energies [...] preservation of biodiversity, and universal access to all public goods worldwide³⁹”*.

³⁹ <http://www.diplomatie.gouv.fr/fr/politique-etrangere-de-la-france/climat/paris-2015-cop21/actualites-et-evenements-lies-a-paris-climat-2015/article/paris-2015-cop-21-discours-du-president-de-la-republique-30-11-15>.

Ethical issues arising out of the erosion of biodiversity

The principles for the protection of biodiversity should be viewed in perspective with the vulnerability of a large number of human populations. Without any intention of disputing the importance of measures to protect threatened or endangered species, ethically speaking it must be remembered that 15% of the world's population gains a living from the use made of these wild animal species, and that, in certain regions, the most vulnerable populations, amounting to a billion human beings, rely directly for their survival on the exploitation of wild species as a source of food.

This example shows that the protection and use of biodiversity require a more complex ethical analysis than simply to aim for global conservation. A systemic analysis must also take into consideration the survival of populations, the risks of conflict arising out of the scarcity of natural resources,⁴⁰ and the possibility of maintaining and regenerating a species exploited in a given ecosystem. Solidarity in terms of access to food resources must be compatible with the local exploitation of species. This is also true for species protected by an international convention such as CITES⁴¹, in particular when it is possible to balance the resilience of populations of wild species with their local exploitation while simultaneously launching development policies for the human societies concerned.

The extermination of large carnivores, traditional in areas of animal husbandry, to protect herds and flocks should be the subject of specific analysis⁴². These are socially sensitive subjects, mainly in developed countries, and compensation for losses blamed on predator activity contributes significantly to settling social conflicts⁴³ although it takes the place of the essential debate on maintaining biodiversity⁴⁴. For instance, in the case of the reindeer in Northern Scandinavia, livestock mortality is compensated even though it is more largely the result of overpopulation induced by economic practices than of predation by lynx and wolverines⁴⁵.

In a context of biodiversity erosion and of reduction in the numbers of populations of wild species of economic interest, increased difficulty of drawdown as in, for instance, fisheries, leads to deterioration in the living standards of the most deprived human populations as regards their basic supplies and also to a decline in their working conditions. The drop of numbers of animal and vegetable populations used as a source of food leads to economic and social change, even before various species are lost. Overfishing, by triggering a collapse of large numbers of fish stocks gives rise, for example, to fishing and aquaculture efforts in which the price paid for profitability is deteriorating working conditions for a sector providing 10% of the world's employment opportunities⁴⁶.

⁴⁰ Brashares J.S. *et al.* (2014). Conservation policy. Wildlife decline and social conflict. *Science* 345, 376-378.

⁴¹ CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora. Also called the Washington Convention (1973).

⁴² Berger K.M. (2006). Carnivore-livestock conflicts: effects of subsidized predator control and economic correlates on the sheep industry. *Conservation Biology* 20, 751-761.

⁴³ In 2011, compensation from the Norwegian Government represented (€9.5 million) an amount equivalent to two thirds of the sum drawn from sales.

⁴⁴ [Redpath](#) S.M. *et al.* (2013). Understanding and managing conservation conflicts. *Trends in Ecology and Evolution*, 28, 100-109.

⁴⁵ The role of predation and food limitation on claims for compensation, reindeer demography and population dynamics. Tveraa T. *et al.* (2014). *Journal of Applied Ecology*, 51, 1264–1272.

⁴⁶ FishWise (2014). Trafficked II: An updated summary of human rights abuses in the seafood industry. www.fishwise.org/services/human-rights

UNICEF draws attention to the fact that in the fishing and aquaculture sectors, children are working in conditions close to slavery in several regions of the world, in particular in developing countries⁴⁷.

Solidarity and ethical reflection need to be mobilised to analyse the issue of the protection and use by mankind of wild species whilst taking into account prospects of fighting poverty and the long term management of natural resources.
To progress from individual sensitivity to collective action will necessitate global governance, but also the firm support of an accountable, active and fully aware civil society.

- The scientific community's contribution to the evolution of law

For historical reasons, there is no obvious connection in legal terms between the vast domain of human rights and that of nature, the environment and biodiversity. Nature has never been central to the development of human rights, but addressed rather from the angle of ownership and setting the limits thereof⁴⁸. Rights over nature were mainly constructed with a view to its appropriation and although there has been indisputable progress compared to former arbitrary appropriations, there is still plenty of room for improvement both nationally and internationally.

The absolute right to do as one wills with one's private property no longer exists. For fields and forests for instance, in the interests of long-term progress, proprietors are obliged to take ever greater precautions in the use made of what is, nevertheless, rightly "their" land and, generally speaking, economic activity is no longer justification for polluting the environment, be it someone else's property or your own.

These legal developments go hand in hand with the progressive perception of utility. Awareness that losses to biodiversity lead to factors favouring poverty and increase the intensity of climatic change is gaining increasing prominence in legislative and regulatory decisions⁴⁹. International agreements now contain regard for the best interests of populations supplying products from which ecosystemic services are provided. This is, for example, the case for the recent (2012) "*Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization (ABS) to the Convention on Biological Diversity*" which was reinforced in French law in 2016 by the recent adoption of a law on "Re-appropriation of biodiversity, nature and landscapes" which combines protection and restoration measures, while it also integrates the dynamic dimension of biodiversity.

In a context where pressure from society has led no further than a partial transcription of measures into law, the ethical approach must step in to steer choices and decisions for which

⁴⁷ Training manual to fight trafficking in children for labour, sexual and other forms of exploitation (2008). International Labour Organization. International Programme on the Elimination of Child Labour (IPEC). Geneva, ILO, 113 p. ISBN 978-92-2-222069-4. Geneva, ILO, 113 p. ISBN 978-92-2-222069-4.

⁴⁸ Property is a part of human rights: you can own a house, a field, a forest and do what you will with them. There is a right of *usus* and even of *abusus*. These rights are generally speaking also those of States; there is such a thing as State-owned property, just as there is private property.

⁴⁹ Going further than international agreements, some States are well in advance on this point, for instance South Korea stands out with its standards for the improvement of its forest cover which has grown from 34% to 64% between 1960 and 1990.

the scientific community, because of the rapidly growing store of knowledge and expertise it accumulates, has a special collective ethical responsibility to act as a whistleblower. Ethical reflection, anchored in the accountability of scientists, and also that of civil society, can help to identify pathways for action and to bringing about changes in the law.

- The meaning of 'sustainable development' ?

Given the inequalities prevailing across the planet, where 20% of humanity controls, manages and consumes 80% of its resources, while a substantial part of the population does not have access to food, safe drinking water and health care, a sustainable development policy reaffirmed by the 17 goals adopted by the United Nations⁵⁰ will promote global governance based on principles of equity and justice, under the critical eye of true democracy guaranteeing in the here and now the implementation of its objectives on a local scale. With the invention of the concept of multi-scale global governance, implying in the long term associations of users of common resources⁵¹, it is also an experiment in involving citizens, in their social and cultural diversity, in accountability for their "common home".

At a time when technology developed thanks to the progress of science has unprecedented global repercussions on the environment and on biodiversity, it is essential to counter concerted efforts to call in question both knowledge gained and existing forms of solidarity. Both, on the contrary, should be cultivated on the basis of new paradigms, jettisoning the utopia of nature in the service of mankind, but seeking, both at a local level and through the instruments of global governance, the synergies between the possible developments of humanity and respect for dynamic ecosystem processes and the evolution of species.

V. Broaden ethical reflection to include the relationship between humanity and nature

Sharing with society as a whole the points identified in the course of this reflection is a major objective in terms of ethics and the sharing of knowledge acquired in the life and health sciences. This objective incorporates a definition of biodiversity going beyond a mere inventory of the current diversity of the living world and aims to provide every citizen with the tools for reasoned interaction with other species and, more generally, with natural processes. The main difficulty lies not so much in the definition of terms as in the way in which the issue of biodiversity and what it encompasses is perceived so that humans may live in harmony with it.

- Cultural representations of the relationship to nature

While the relationship to nature of each society is the result of its own cultural representations, growing urbanisation, at a time when the majority of the planet's inhabitants now live in cities, is obliterating the experience of nature⁵². There is a need to study how this contributes to the erosion of biodiversity by modifying social representations: does a limited

50 <http://www.un.org/sustainabledevelopment/sustainable-development-goals/>

51 Latour B. (2015). *Face à Gaïa*. Éditions La Découverte, 398 p.

52 Urbanisation is not desertification. It contributes to the creation of new environments whose implications in terms of health need to be more fully examined. There is also a need to improve education about the environment and to develop awareness of biodiversity.

relationship to nature during childhood or over the course of a lifetime lead to a readier acceptance of its destruction.^{53?}

With a view to sharing and acquiring new learning, participatory research constitutes a pertinent approach, as has been recently pointed out by the CNRS⁵⁴ Ethics Committee and the report⁵⁵ on participatory sciences written by F. Houllier (2016) at the request of the Ministers for Education, Higher Education and Research.

This report recommends a new framing of the questions of biodiversity protection:
- How should the capacity of the living world to create anew be preserved?
- How should desirable approaches be identified among all the possible options?

Scientific advances, within their dimensions of uncertainty, bring about a better understanding of the scale of global environmental interaction and the diversity of the ecosystems structuring the planet. They are also an opportunity to examine how, in their conquest of the whole ecosphere, human societies have developed a diversity of cultural practices in their relationship to the natural systems they live in.

The tensions generated between respect for cultural principles and the standardisation of a certain form of development must be relieved by respect for the practices most appropriate to a given context, and by solidarity between human societies.

Both the speed and the scale of environmental transformation are contributing to the threats weighing on the most vulnerable in developing countries and to societal fractures in industrialised countries. Mounting population migrations on a regional and interregional scale in response to rapid environmental changes are factors affecting health that require consideration as such, but also through the prism of reflection on demography in all of its ethical dimensions. The migratory flows which will affect, *inter alia*, African countries in coming decades, are already having, and will have in the future, a major effect on human health. Can we pay proper respect to the living world we live in if we have no respect for each other? As Barret *et al* emphasise (2016), the way in which man will interact with biodiversity is linked to the way he defines himself as a human being⁵⁶.

Working on the basis of current knowledge and research to be furthered on the diversity of the living world and of the interactions in play, the most important course of action is to step beyond the nature-domineering approach that is associated with excessive exploitation and still frequently persists in its influence on the practices of biological and ecological engineering.

Challenging the domineering attitude has several ethical dimensions: nature is no longer to be exploited or dominated.
On the contrary, we must seek to coevolve with nature and, at least, be capable of adapting to the transformations that societies thrust on to the planet, so as to avoid

⁵³ The perception of nature and of domestic species is also changing in the human imagination; the law also reflects the transformation in perceptions of nature, as in the case of legislation on subjects as diverse as hunting, bull fighting, coastal conservation, etc.

⁵⁴ COMETS (2015). Avis sur les sciences citoyennes, 13 p. www.cnrs.fr/comets.

⁵⁵ <https://inra-dam-front-resources-cdn.brainsonic.com/ressources/afile/320314-a73a2-resource-synthese-de-la-mission-sciences-participatives-fevrier-2016.html>

⁵⁶ Barret P., Bourguet D., Duée P-H, Gerber S., Le Roux X., Tixier-Boichard M. (2016). *Éthique et biodiversité : questions posées à et par la recherche agronomique*. (Ethics and Biodiversity: questions to and by agronomic research). *Natures Sciences Sociétés*, 24, 270-276.

leaving to future generations a planet Earth that is less propitious for humanity than it is today.

- The debate on the relationship with nature: the ethical approach

Future public debate must consider how the mastery or domestication of nature has often been a step in the direction of its disfigurement and that there are openings for new forms of creativity. While the issue of solidarity is a major one, the debate must consider how far such solidarity can incorporate scientific and traditional knowledge and reflect on how the notion of compensation cannot be reduced to purely financial aspects that would justify the relocation of damage to biodiversity so that some societies would benefit at the expense of others. While growth is a key issue, the solutions adopted by various cultures in environments with different potential must be regarded with an eye for less domination and more solidarity, so as to rethink progress and improve wellbeing in a limited but diverse world⁵⁷.

Reflection on biodiversity is a metamorphosis of the social organisation of the kind that compels us to include a transdisciplinary dimension in our joint deliberations. It leads us to an in-depth study of the history of biodiversity and to describe the sequence we are experiencing today in terms of crisis, irreversible rupture, capability, resilience... which could be a distant echo of the mutation that mankind experienced, over a longer period of time, when we left behind us the hunter-gatherer societies and entered into the Neolithic Era.

We must rethink our relationship to the living world, by relearning the meaning of limits, not in terms of creativity — which must increase — but by calling into question the limits of our “power” to transform and possess the living world. This ethical approach does not only signify that we must take the future into account; we must also integrate the present and the expectations of societies as regards respect for their cultural practices and for a balanced development process.

“The challenge is ethical. Depending on our vision of the future of humanity, depending on our attitude to other living beings, anthropocentric or altruistic, the value we attach to nature, in its greater or lesser diversity, differs. Our innermost values are challenged: is it not a matter of rethinking the way in which we inhabit the planet?” asks P. Blandin⁵⁸ from a perspective of ecological solidarity that could be described as “humanocentric” by giving prominence to the diversity of values and cultural diversities that are the components of that solidarity, a reconciliation with nature that could be the foundation for a reinstatement of the social pact.

Health care policies have been in part fashioned by the prevailing concept of a possible mastery over nature. And so they have privileged a medical philosophy of cure to the detriment of prevention. Such preventive policies⁵⁹, more consistent with current knowledge of the dynamics and interrelations of the living world with nature, are a health care priority for

⁵⁷ In other words, rather than aspire to infinite growth, the challenge to meet would be to move towards an improved distribution of resources and greater protection for the environment. This challenge is as much one of creativity as of equity!

⁵⁸ <http://www.docsciences.fr/La-Biodiversite-entre-science-ethique-et-politique.html>

⁵⁹ The theme of prevention, emphasising as it does the link between health on an individual scale and public health, contributes to the discussion on vaccination. These issues were the subject of Opinion n° 92 on screening for tuberculosis and BCG vaccination (CCNE: June 2006).

developed and developing countries' populations, the latter being the most vulnerable to disease and pollution.

The concept of cooperation within humanity and of otherness in connection with biodiversity carries with it an increased demand for research and for knowledge-sharing through education and social debate. This is the price to pay for harmonious development, precautionary as regards biodiversity, avoiding its destruction because of insufficient information and opposing destruction for the sake of vested interests.

Moving from classic humanism toward a humanism integrated in the living world will facilitate the construction of social, supportive and accountable biodiversity. Humans, components of biodiversity in their own right, will also be safeguarded when biodiversity protection is viewed holistically.

CCNE suggests a furthering of reflection on human health, broadening the scope in order to take into consideration environmental factors and the right for present and future generations to live in an environment that is good for their health.

The report was adopted by all CCNE members on 9 March 2017.

Annex 1 – Erosion of biodiversity: recent awareness, hindered by a multitude of often restrictive definitions

We are bombarded with numerous and pressing alerts to the consequences of damage to biodiversity for human living conditions and health. And yet, our societies seem to have but little perception of how each and every one of them will be affected, even if an increase in the occurrence of catastrophic meteorological events is contributing to increasing awareness of global environmental changes and their anthropic sources. Climatic change is a major demonstration of this, one of the factors participating in the erosion of biodiversity and also a possible instrument for raising collective awareness.

Regardless of the range of cultural models constructed for the relationship between humans and nature, social representations of the diversity of the living world and of where humans fit into this diversity exert pressure on the biological and cultural aspects of humanity, in particular with respect to man's postures of mastery of the living world, including those relating to his own health. Such representations combine disquiet about natural phenomena and a stance as manager of natural resources that has contributed to the development of societies, but also led to a deterioration of human health and to the destruction of species and ecosystems. These social representations as a "manager" participate in the process of exploiting biodiversity and awareness of responsibility for biodiversity which may lead to remedial actions and policies, without however truly anticipating the inevitably limited resilience capacity of impaired ecosystems. Since no account is taken of the dynamic nature of evolving ecological phenomena, the result is that social representations and measures adopted frequently ignore the fact that there can be no return to a previous status, only a shift to a new status.

Massive and rapid erosion of biodiversity.

At the end of 2014, out of 76,199 species under examination by IUCN⁶⁰, 22,413 were considered to be under threat of extinction, according to the latest update of the red list⁶¹. In terms of ecological environments, they represent 33% of reef-building corals. In terms of groups, they include 41% of amphibians under study, 31% of rays and sharks, 25% of mammals, 13% of birds, 24% of conifers, etc. Among these threatened species, 4,635 are considered to be critically endangered, 6,940 are classified as "endangered" and 10,838 as "vulnerable". France, because of the biological diversity of its overseas ecosystems, is classified as 5th of the most concerned States, with 983 animal and plant species under threat⁶².

At a time when, beyond the scientific aspect, global climate change has become an emblematic theme of the impact of human activity on the environment, scientific studies point out that other anthropic disturbances of natural dynamics may also have significant global repercussions. In 2009, *Nature* published a collective article⁶³ underlining that the nitrogen cycle and the loss of biological diversity are showing signs of disruption — as is also the case for climate change — on a larger scale than variations encountered since the early Holocene⁶⁴.

⁶⁰ IUCN: International Union for the Conservation of Nature.

⁶¹ <http://www.iucnredlist.org/search>

⁶² http://www.uicn.fr/IMG/pdf/Communique_UICN_France_Liste_rouge_mondiale_2012.pdf

⁶³ Rocström J. *et al.* (2009). A safe operating space for humanity. *Nature*, 461, 472-475.

⁶⁴ These same findings have given rise to the concept of a new period focusing on the influence of human societies beginning with industrialisation since the 18th century: the Anthropocene. Crutzen P.J. (2002). Geology of Mankind. *Nature*, 415, 23; Stephen W., Crutzen P.J., McNeill J. (2007). The Anthropocene: Are Humans now Overwhelming the Great Forces of Nature. *Ambio* : A journal of the human environment, 36, 614-621. A point worthy of note is that this expression, which places human influence on a par with major natural crises, is not innocent of all notion of humanity's supremacy over nature.

Apart from the 832 species scientifically recognised and identified as extinct, 69 species no longer exist in the wild and only survive in artificial environments (parks, animal reserves, etc.) as so many tokens of the acceleration of erosion.

Definitions of biodiversity where the role of human beings and of humanity varies.

Biodiversity is still defined in a vast number of different ways, even though there may be convergence around considering it as a state of biological diversity but also recognising that it varies with time, space and within species. A number of definitions also insist on the interaction between biodiversity and the environment. This is the case of the definition adopted for scientific purposes back in 1988, by IUCN: *Biological diversity, or biodiversity, is the variety and variability of all living organisms. This includes genetic variability within species and their populations, the variability of species and their forms of life, the diversity of complex associated species and their interactions and that of the ecological processes they influence or of which they are actors ([ecosystemic diversity]).*

The expression was also widely appropriated by the non scientific community, and it was first used in 1992 at the United Nations Conference on Environment and Development (1992), often referred to as the “Rio Earth Summit”. The conference gave prominence to the concept of sustainable⁶⁵ development for human societies, “in harmony with nature”. It did not use the word “biodiversity” in its closing statement but adopted a “Convention on Biological Diversity” (CBD) which extended the scope of this term to the social domain; it underlined the importance of biodiversity for humanity in the very first paragraph of the preamble:

⁶⁵ The translation of the English word “sustainable” by “*durable*” in French is not satisfactory although it is in common use. Furthermore, “*durable*” in combination with “*développement*” is an oxymoron which does not define the dynamics of the phenomena in question and the attitudes that need inventing to maintain the objectives of societal progress and solidarity. Bergandi D., Blandin P. (2012). De la protection de la nature au développement durable : Genèse d’un oxymore éthique et politique. *Revue d’histoire des sciences*. 65, 103-142.

“The Contracting Parties, ... Conscious of the intrinsic value of biological diversity and of the ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values of biological diversity and its components, ...”.

In France, the National Strategy for Biodiversity which follows on from the ratification of CBD, refers to the above definitions in its 2004-2010 programme when it insists on the services rendered to human societies by biodiversity, using the term “ecosystemic services”⁶⁶, and on the duty to preserve it, without, however, explicitly insisting on the need to include humans as one of the component species of biodiversity⁶⁷: *“Biodiversity is an essential dimension of the living world. It is expressed by genetic diversity, the diversity of species and the diversity of ecosystems. It carries the evolutionary potential which is a guarantee of the capacity for adaptation of species and ecosystems when confronted with global change. Biodiversity, with the goods and services it offers, is a vital asset for human societies. The uses made of it have had an impact on the land and shaped it. It is, in fact, a repository for symbolic, cultural and identifying values. Man must preserve the diversity of the living world for ethical, cultural, biological and ecological reasons, but also for the sake of the economy”*⁶⁸.

The concept of ‘ecosystemic services’ emphasises the usefulness of biodiversity for humanity, including for reasons of health, but it would be questionable in ethical terms if it did not take account of possible reciprocity

⁶⁶ FAO for example, considers that 71 of the 100 cultivated plants feeding 90% of mankind are pollinated by various kinds of bees, i.e. “a service” very approximately estimated at 200 billion dollars per year www.fao.org/ag/magazine/0512sp1.htm.

⁶⁷ Although this point is mentioned, for example, in the World Charter for Nature, adopted in 1982 by the United Nations General Assembly.

⁶⁸ During this phase of the programme, an “environmental vocabulary” was published in the *Journal Officiel* of 12 April 2009 and provides a relatively brief definition of biodiversity: *“Diversity of living organisms, evaluated through a consideration of the diversity of species, of genes within each species, and the organisation and distribution of ecosystems. Preserving biodiversity is an essential component of sustainable development.”*

with “non-humans”, since it sets humans as central to the biotic community.

In the same time period, the Preamble to the *Charte de l’Environnement* (2004) makes a very close connection between humans and biological diversity: “*That natural resources and balances have conditioned the emergence of humanity; that the future and even the existence of humanity cannot be dissociated from its natural environment; that biological diversity, individual wellbeing and the progress of human societies are affected by certain forms of consumption or production and by the excessive exploitation of natural resources*”. This bond between human societies and biological diversity is therefore an integral part of French “constitutionality” since 2004.

The current National Strategy for Biodiversity programme (2011-2020), points out that: “*Living beings, humans among them, together form the biosphere, the living fabric of the Earth. Individuals, some more ephemeral than others, are born, reproduce and die. Thus they form a dynamic chain linking species together and to their environment*”⁶⁹.

A very partial social grasp of the concept of biodiversity and an ethical issue: understanding needs broadening to encourage informed choices.

The consequences of impaired biodiversity seem to be remote in social representations and, while definitions of biodiversity have changed over time, their social appropriation often ignores the dynamic aspects of variability, the interactions at play and the fact that humanity⁷⁰ is a component species of

⁶⁹ The magnitude of the dynamics involved and the situation of humans as a constituent part of today’s biodiversity are two of the most difficult concepts to share and it is perhaps regrettable that the expression “biodiversity” is defined in an overly static fashion and without any explicit reference to humans in the document’s glossary:

“*Designates the diversity of living beings. This diversity is expressed and is active at all the organisational levels of life: diversity of the species; diversity within a species, between the individuals who are its components at a given point in time; ecological diversity, that of associations of species in a given environment.*”

MEDDE (2012). Stratégie nationale pour la biodiversité 2011-2020. Glossaire, 56-57.

⁷⁰ Species itself is a dynamic concept and although humanity today is made up of *Homo sapiens*, we can also

biodiversity despite the specificities of its cultural development.

National and international (cf. *infra*) studies (IPSOS, CREDOC) on the social representations of biodiversity have recently confirmed the limits of knowledge and representations.

The most common understanding by French society of biodiversity is restricted to a catalogue of diversity and to possible losses of ecosystemic services for the wellbeing of humanity with no consideration of the direct and indirect causes of its continuing changes. This limited grasp is incapable of producing a definition of the most appropriate action to preserve diversity.

The same difficulty arises with reference to the necessary grasp of biodiversity in the common body of knowledge as defined by the Code on Education (Decree n° 2006-830 of 11 July 2006, Annex).

Public appreciation of the concept of biodiversity seems essential to enable citizens to make a competent analysis of the issues involved and the decisions to be made.

At the international level, the secretariat of the Convention on Biological Diversity, in its 2014 report⁷¹, states that analysis of “*underlying causes or indirect drivers of biodiversity loss*”, had led to defining among the primary objectives of the Strategic Plan for Biodiversity 2011-2020, the requirement that “*by 2020, at the latest, people (become) aware of the values of biodiversity and the steps they can take to conserve and use it sustainably*”. Progress on this point appears difficult, since the report goes on to say that “*evidence suggests a growing knowledge of possible actions, but limited understanding of which of them will have a positive impact.*” Close on 70% of people who are asked have heard of “biodiversity” (but with major disparities since

_____ speak of past humanities, or even consider that several humanities may have existed within the same time frame, depending on whether we consider that *H. sapiens* and *Neanderthalensis* are, for example, two species or two populations of the same species.

⁷¹ Secretariat of the Convention on Biological Diversity (2014) – 4th edition of the Global Biodiversity Outlook <https://www.cbd.int/gbo4/>.

this seems to be the case for 94% of French nationals), but the percentage of people who were able to provide a “correct” definition has not progressed since 2011 and is still less than 30%⁷².

Although those interviewed are aware of the importance of biodiversity for human wellbeing, they do not necessarily consider that protecting biological diversity is an essential contribution to their wellbeing and that of humanity.

⁷² Two studies, one by IPSOS and the other by CREDOC, report levels of between 34 and 35% of correct representation by the French population in 2014 but, as mentioned above, these studies do not seem to cross-reference the declarative practices of those questioned with definitions of biodiversity incorporating the dynamics and interactions involved, which limits the scope of the studies and could mean that the levels of appropriation of biodiversity concepts reported in international studies are greatly overestimated.

Annex 2 – Biodiversity is linked to biological evolutionary processes with which human societies are increasingly interfering

The dynamics of natural processes are, depending on the kind of society involved, more or less integrated into the perception that individuals have of their environment, of other individuals and of themselves. Less prominent in western cultural representations than in other cultures, this complexity is often underestimated, all the more so because urbanisation – which now concerns most societies – loosens the relationship between human beings and nature.

Changes in biodiversity, introduced since the beginning of the Neolithic Era *inter alia* by the domestication of living species and deep-rooted changes to the environment of all human societies, over thousands of years have given rise to cultural and technical concepts of control over the living world that have led societies to confuse progress with humanity's domination of nature.

Early approaches during the 19th century to scientific conceptualisation of diachronic dynamics, leading to the theory of evolution, clashed, violently at times, and still stand in opposition to the social representation of a globally stable nature (Creationism) or nature only transformed by one or a few disasters. This representation takes no account of the unceasing dynamic processes and interactions occurring over three and a half billion years.

The synchronic dynamic approach that gave rise to ecological concepts did not meet with as much formal opposition but was the subject of a host of interpretations to the effect that societies could control natural processes for their own uses, or even “repair” such or such a deterioration brought about by anthropic action which turned out to be excessive. This process in fact ignores the complexity of the interactions involved and the dynamics of ecosystems that are such that a natural system, once disturbed, does not usually revert to its previous state but shifts, instead, to a new and different state⁷³.

⁷³ Even in an environment *a priori* as simple as a cave, rapid change brought about by the arrival of human presence can, in just a few years, unbalance an ecosystem

Moving on from a domineering attitude of humanity⁷⁴ to a more harmonious and dynamic vision of the relationship between humanity and the rest of the living world requires consideration of the multiplicity of continually interacting diachronic and synchronic processes involved. Such a change of approach is of major ethic significance.

Continuing research and sharing information on the interactions which fashion the biological diversity of species at a given point in time and allow them to evolve, are two essential conditions for the preservation of biodiversity and the wellbeing of present and future human societies.

In parallel with continuing research, sharing of knowledge is crucial so that appropriate technologies can be chosen and informed decisions taken. Ethical reflection, however, must be part of the process so as to question the pertinence of such concepts as “conservation”, “stability” and “sustainability” when applied to biodiversity and, more generally, to nature. Also, critical analysis would be useful to examine expressions such as “crisis”, “management”, “compensation” and “restoration” which may well contain a large measure of illusion and underestimate the dynamics and complexities of the processes involved.

Among the interactions and dynamics involved, those related to demography, following on the writings of Thomas Malthus⁷⁵, were the object of study and raised

built up over a lengthy period of time, so that despite the deployment of technology as powerful as, for example, that used in the Lascaux cave to protect the prehistoric wall paintings, it was not possible to control the interaction between microorganism populations and their new dynamics.

⁷⁴ It should be added that this is more of a duality since the domineering attitude of humanity is not in contradiction with the situation of endangered populations who have no choice but to adjust to an environment. This also, in more specific cases, defines the situation of populations amid a natural disaster.

⁷⁵ Malthus T.R. (1798). An Essay on the Principle of Population. J. Johnson Jr ed., London.

major ethical issues which are still of the utmost importance for the future of humanity. It should however be noted that certain “Malthusian” analyses start from a reductive vision of the human species and its place in the living world when they rely exclusively on the laws of the living world to characterise human action, thus minimising human capacity for cultural adaption and, more generally, for creativity⁷⁶.

As regards biodiversity, growth of human populations is accompanied by pressures, through the extension of inhabited areas and the changes to those areas and also due to the greater drawdown of species for food and for industry. Simultaneously, more information about current diversity can help to improve response to the needs of global populations which numbered one billion individuals in the 19th century and has now reached a total of over seven billion.

Although it is appropriate to reaffirm that the human species is a part of the history of the living world and its diversity today, we must also remember that mankind, before it ever drew up the laws of biology, had already multiplied animal and plant species to suit its purposes, and even created new species as common as, several millennia later, dogs, corn and maize. With its endless creations —both living and non living⁷⁷ — humanity has helped to partly exempt itself from certain factors regulating other species and societies of living organisms. This takes place thanks to education and more specifically through health care and regulating human reproduction, if one considers for example, human demography.

the boundaries of what is known and also because biodiversity and its future evolution contain an intrinsic component of unpredictability.

Understanding where each human being, and human beings collectively, fit in amid the living world, raises the issue of mankind’s accountability, both with regard to other components of biodiversity and to itself. This ethical issue is all the more worthy of consideration because decisions taken by societies in interaction with the living world are taken in a situation of relative uncertainty, the horizon of certainty being circumscribed by

⁷⁶ This is one of the traits, among others, of sociobiology.

⁷⁷ « Ce vivant dont les gestes mêmes font surgir dans le monde autre chose que ce qu’engendre la vie ». Tinland F. (1977). La différence anthropologique. Essai sur les rapports de la nature et de l’artifice. Aubier, Paris, 453 p.

Annex 3 – Humanity’s exactions on the diversity of the living world: an ancient scientific analysis, reviewed in the light of global change caused by anthropic activity

Beginning in the 18th century, scientific thinking regarding the diversity of species and their fragility evolved in parallel with their description and systematic denomination. Already, backed by solid reasoning, scientific literature warned of the vulnerability of certain species exposed to over-exploitation by human societies⁷⁸.

During the 19th century, developments in the theory of evolution and ecological concepts led to a more precise definition of species as dynamic entities interacting among themselves and with natural environments. In parallel, the notion that the planet has only limited resources reinforced the scientific community’s awareness of the consequences of demography, so that the two concepts combined to initiate the thought that man could very well make the planet unfit for his own survival.

The coining in 1866 of the word “ecology” by Ernst Haeckel consolidated the conceptualisation of the dynamic processes which activate species in their environments.

Already at that time, several works referred to the risk of major disturbances in the balance

between species. One of them, “*Man and Nature*” (1864) by George Perkins Marsh, is an overview of the founding studies of modern ecology. It develops with great precision the notion that the planet is a finite entity whose balance can be disturbed by mankind to the extent that it would become inhospitable for mankind itself⁷⁹.

At the end of the 19th century, such scientific concepts led to procedures for the protection of species deemed to be endangered, by the creation of safe havens for them in territories contained within areas owned by the western nations and their colonies⁸⁰, and later by creating lists of protected species⁸¹. International agreements were signed in the early years of the 20th century, in particular to protect migrating species⁸², although they did not go so far as to impose global measures and were confined to lists of precise species and to specific protected areas.

Protective measures adopted until the middle of the 20th century were essentially concerned with principles of natural resource management to further the purposes of the

⁷⁸ Buffon wrote on the subject of hunting cetaceans: “*It has been noted since fishing for, or rather hunting for these large animals began, that they have fled from places where men could harm them. Furthermore, it was observed that the early whales, those which were caught a hundred and fifty years or two hundred years ago, were much larger than those of today: they measured as much as a hundred feet in length.*” (*Histoire naturelle*, 1755, Tome V supplement). Lacépède, one of Buffon’s successors as author of *Histoire Naturelle*, writes in the introduction to *Histoire Naturelle des Cétacées*: “*...when the art of navigation began to improve and the compass could help sailors negotiate the dangers of the most distant oceans and the shadows of the darkest nights, enticed by the treasures to be gained from victory over the cetaceans, man disturbed the peace of their immense seclusion, violated their refuge and slaughtered all those that the icy and inhospitable polar deserts could not protect from their attacks. Man’s war against them was all the more cruel when it became clear that these great whale hunting expeditions governed man’s commercial and industrial prosperity, the number of seamen, the boldness of navigators, the experience of pilots, the strength of the navy, the magnitude of power. Thus fell the giants among giants [...] and they will only cease to be the victims of man’s purposes when these gigantic species are no more [...]. Their only asylum is oblivion*” (*Histoire naturelle des cétacées*. 24 Nivose An 12).

⁷⁹ In *Man and Nature; or Physical Geography as Modified by Human Action*, George Perkins Marsh wrote: “*Hence the action of man upon the organic world tends to subvert the original balance of its species, and while it reduces the numbers of some of them, or even extirpates them altogether, it multiplies other forms of animal and vegetable life...The earth is fast becoming an unfit home for its noblest inhabitant... and human improvidence, [could] reduce it to such a condition of impoverished productiveness, of shattered surface, of climatic excess, as to threaten the deprivation, barbarism, and perhaps even extinction of the species.*” (1864 ; J.F. Trow ed., New York).

⁸⁰ The first natural park was Yellowstone, created in 1872 in the U.S.; similar creations were developed in Scandinavia from 1909 onwards. As for France, several “sanctuaries” were created in its African colonies in the 1920s, some forty years before any were inaugurated in mainland France. In non western countries, Japan created its first three national parks in 1934 and China in 1982.

⁸¹ For example, the March 1924 decree on limitations to whale hunting from the coasts of French West Africa or the Convention on the protection of bird species useful to agriculture in 1902.

⁸² The International Convention for the Protection of Birds Useful to Agriculture, Paris, 19 March 1902.

societies taking the measures, without considering the totality of the ecological processes or the concepts of thresholds and resilience that ecology and genetics later documented, although the phenomena generated by these issues were already known at the time⁸³.

Against this “conservationist” approach for the reasonable management of resources, both for the benefit of future generations and for the immediate development of society is juxtaposed a “preservationist” moral approach with the view that nature and species were not created for the sole satisfaction of mankind and that their preservation is justified in the name of moral and aesthetic principles, the continued existence of natural wilderness being essential to all members of the human species to be able to get back to their roots⁸⁴. These two trends emerged at the end of the 19th century in the United States, but continue even now to filter through in the approaches of both political leaders and scientists as can be observed from sometimes tense drafting in more recently adopted international agreements⁸⁵.

The ethical dimension of the relationship between humanity and all the other living species has been gaining recognition in recent decades.

The scientific affirmation that preservation of biological diversity requires a more global approach than simply protecting some designated species was first evidenced in international policies in 1982 with the United Nations World Charter for Nature⁸⁶. While this

83 The extinction of the American Passenger Pigeon *Ectopistes migratorius*, whose population of several billion individuals was hunted down and plummeted drastically during the whole 19th century until the species died out, led to the notion of critical population size which preceded those of threshold and resilience.

84 The “conservationist” movement proposes a strictly anthropocentric ethic. One of its initiators was the forestry engineer Gifford Pinchot (1865-1946), an aide to Theodore Roosevelt. The “preservationists” proposed ethical principles foreshadowing the ecocentric ethical approach favoured, among others, by the American naturalist John Muir (1838-1914).

85 For example, the need to recognise the intrinsic value of other organisms, echoing the “preservationist” approach, is nevertheless contradicted in the following article arguing in favour of a “conservationist” approach.

86 United Nations World Charter for Nature adopted by the General Assembly on 28 October 1982.

non binding charter is less well known to the media than the 1992 Rio Conference and the Convention on Biological Diversity signed on that occasion, it highlights the essential points still under current debate to this day, be it the dynamic definition of biodiversity and the place of man within it.

The 1982 Charter demonstrates, from the preamble onwards, an approach that expressly links science, ethics and policy. The very first paragraphs define the perimeter of reflection when they associate the “preservationist” and “conservationist” approaches mentioned above:

- *Mankind is a part of nature and life depends on the uninterrupted functioning of natural systems which ensure the supply of energy and nutrients,*

- *Civilization is rooted in nature, which has shaped human culture...*

It also introduces the principles of the Convention on Biological Diversity presented at the Rio Earth Summit in 1992:

“The genetic variability on the Earth shall not be compromised; the population levels of all life forms, wild and domesticated, must be at least sufficient for their survival...”

Increased knowledge of humanity’s exactions on the diversity of life forms: from a catalogue of the living world to the preservation of its capacity for evolution.

A better understanding of living organisms and of their phylogenies has helped to raise awareness that the number of living species had been greatly underestimated. For example, in the case of fungi, the number of species already described might be, based on molecular data, only about 2% of existing species⁸⁷.

Directly pathogenic or commensal species, involved in the health of human beings, as well as of a number of domestic and wild species essential to human nutrition, be they insects, worms, microfungi or bacteria, are all unexplored fields for research in which our only certainty is that only a minority of species

<http://www.un.org/documents/ga/res/37/a37r007.htm>

87 Taylor D.L. *et al.* (2014). A first comprehensive census of fungi in soil reveals both hyperdiversity and fine-scale niche partitioning. *Ecol. Monogr.*, 84, 3-20.

are known today. In terms of human health, the discovery of the microbiota has contributed to our understanding that all multicellular beings, including each and every human being, is a dynamic and complex ecosystem.

In parallel, advances in the understanding of ecological systems contribute to building models of systems and to an ever greater understanding of how phenomena generated by anthropic activity affect the diversity of species. This was the case in recent times, for instance, with the discovery of the extent of ocean acidification, whose impact on biodiversity seems considerable and capable of interfering, quite as much as rising sea levels, in the future of human populations in terms of coastal habitats and global food resources.

The scientific data to alert decision makers to the dangers of biological diversity losses and threats to the very future of the living conditions of human populations has long been available. Some thought should therefore be given to the kind of research needed to arrive at a better understanding of the current upscaling of biodiversity erosion and to the reasons why society and decision makers are not more reactive to these issues⁸⁸.

Taking health for instance, we need to consider how the ambition to control the living world has contributed to a preference for curative care to the detriment of preventive policies more in harmony with the concept of co-adaptation between humans and the rest of life on earth.

Invalidating the age-old social representations based on control over the living world which still have currency in today's societies, while recognising that they have made contributions to the progress of the life and health care sciences, requires a sharing of knowledge, but

also requires debate. Such debate will be all the more profound if it aims for a change in society with progress to be conceived in terms of reasoned coevolution with the rest of life on earth and incorporates a portion of the unpredictability which is the hallmark of natural phenomena.

⁸⁸ The fact that, in terrestrial ecosystems, all mammals weighing over 2.5 kg under threat of extinction are carnivores, with the exception of the panda, is evidence of the spirit of competition, real or imagined, which has long prevailed in the relationship of humanity with other living species on Earth. Similarly, the social representations concerning the competition between humanity and certain species classified as 'pests', underlines the importance of sharing knowledge on biodiversity and the amplitude of the subjective obstacles to be overcome.

