Thoughts on the notion of biodiversity

The efforts and activism of experts in conservation biology greatly contributed to the emergence, dissemination and success of the notion "biodiversity", which has now become a buzzword as noted by Takacs (1996).
But how should we interpret the widespread acceptance by the scientific community of a notion that is often considered a hodge podge of ideas?

Robert Barbault often defines biodiversity as "the living tissue of the planet" (2008), a very (overly?) general definition, but which has the advantage of expressing, above and beyond the diversity of life forms, the almost infinite web of interactions between the organisms present in the biosphere.

A number of different disciplines have adopted the notion and each has produced a scientific definition for different levels in the structure of life. They distinguish the genetic diversity of populations (and of species on a larger scale), the specific diversity (i.e. the number and relative distribution of species) of functional groups (and of ecosystems and landscapes), the functional diversity of ecosystems (i.e. the number and types of interactions between functional groups). It is also possible to link the diversity of habitats to the dynamics of how they are assembled in order to study the functioning of an ecological landscape mosaic. Though the notion of biodiversity itself is fuzzy, it can be subdivided into various precise scientific definitions depending on whether the topic is population dynamics, ecosystem operation or ecosystem complexes. We may therefore wonder how these various biodiversities can legitimately be placed under the single heading of "biodiversity".

One reason is a hypothesis currently studied by ecologists, i.e. that the biodiversities defined for the different levels in the structure of life (a population, functional group, ecosystem, landscape) can all bestow, on each level, the capacity to adapt to changes in that environment.

In abandoning the general concept of E. Odum based on the "balance of nature" (Odum, 1953), scientists now tend toward a dynamic view of ecology and include disturbances as structuring factors in biotic communities. It is now accepted that the environments surrounding us are the product of their history, including the disturbances encountered and those encountered by the other environments with which they interact. The degree of species richness and the structure of ecosystem mosaics are the result of a historic process in which natural and anthropogenic disturbances combine. That transforms the way we perceive human activities because the imbalances caused by people are not necessarily more catastrophic than those caused by nature. We can no longer see humans as the bull in the china shop of natural balances. Human activities and constructions must be included within the scope of ecology (Larrère and Larrère, 1997; Blandin, 2009). At the same time, we observe the development of ecological engineering that can be used to restore environments, guide the development of biotic communities, reinforce certain populations or reintroduce species that have disappeared from a given region. The goal of ecology is now to assist in managing nature (Chapuis *et al.*, 2002).

In this dynamic view of ecology, our handling of nature can no longer consist of attempting to maintain its balances, nor protecting the integrity and stability of ecosystems. Even without human intervention, the notions of integrity and balance are relative in a context of perpetual change. Rather than stability, the issue now is the capacity to adapt, i.e. the resilience (Gunderson and Holling, 2001) of populations, environments, environmental mosaics, etc. to the new disturbances confronting them.

There is thus convergence between the new perspectives of scientific ecology and the idea that biodiversity is a good thing for each level in the structure of life where it can be defined and, consequently, for nature in general.

This is where another explanation of the widespread acceptance of biodiversity comes into play. If it can be presented as various descriptive concepts, then biodiversity is a prescriptive notion. That is no doubt due to its origins. Conservation biodiversity developed as a mili-

❶ In mountain, vegetal species disappear with the boom of the tourist activities. Revegetation rebuilds step by step the natural ecosystem and contribute to the biodiversity.

tant form of science whose goal was precisely to preserve biodiversity and to protect it. Similarly, if we return to the image of the "living tissue of the planet", it becomes clear that the term in itself implies that protecting life also means protecting the diversity of life. It is this general idea that is reinforced by the hypothesis that at each level in the structure of life, the various biodiversities are a positive factor for resilience.

Concerning specific diversity, scientists are in agreement that an extinction is underway and it is progressing faster than the other extinctions that the planet has known. Human activities are thought to be responsible through a complex set of intermingled causes, including excessive consumption, systematic destruction of "pests", cutting of tropical and equatorial forests, agricultural and industrial pollution, urbanisation and infrastructure fragmenting habitats. The species eliminated by human activities are the product of evolutionary processes spanning millions of years. There is an intuitively shocking disconnect between activities motivated by short-term interests and their irreversible consequences. They also note that evolution, through a succession of extinctions and speciation phases, tends to increase the diversity of species and that natural selection implies the existence of genetic diversity in populations. An intuition that is difficult to express suggests that it would be unwise to harm these biological diversities which are both the result of natural selection and its raw material. It is the evolutionary potential (on the various levels in the structure of life) that must be preserved in biodiversity (Blandin, 2009).

Biodiversity can thus be considered a positive factor for nature, but it also constitutes a very rich set of resources and is therefore important for humans. Living species, with their genetic heritage and their many interactions are also "natural resources" and the source of "ecological services" beneficial to humans. Human activities render species extinct, but it is not because species have no apparent utility today that they will never have any. We are denying our descendents access to resources that they could have used.

According to Bryan Norton (1991), an ethical system that values only the "resources" that nature can provide can result in effective protection of areas and living beings from abusive exploitation (or neglect), it is simply necessary to widen the notion of "resource". Above and beyond resource use (raw materials and energy, food and therapeutic uses, etc.), we must take into account other "resources" that can be scientific (we hardly know all living species much less their potential), aesthetic (the beauty of certain species, environments and natural landscapes), even symbolic or religious (in spite of their diversity, all human cultures attribute symbolic value (or supernatural qualities) to certain species, certain sites, certain landscapes). Finally, we must take future generations into account if we are to transmit a "natural heritage" capable of fulfilling their future desires and needs. To that end, we may consider that each generation must let future generations, whose needs and desires are unknown, decide for themselves how they want to use the natural "resources". That means that we must not leave behind an environment that has been destroyed and is unfit for human beings (Jonas, 1979). We must also do our best to avoid irreversible situations, i.e. extinct species and irreparable environments. Finally, the more there is genetic diversity within species, specific diversity in environments, habitat diversity in territories, the more it will be possible for future generations to decide how they wish to use their heritage.

Biodiversity, justified as a positive standard by both an expanded anthropocentric ethic and by an ecocentric ethic, intent on preserving the evolutionary capacities of species and environments (to say nothing of the biocen-

tric ethic which, because it attributes an intrinsic value to all living organisms, strives on principle to enhance specific diversity), can be seen as a standard for action and the various biodiversities as evaluation criteria for spontaneous or managed trajectories. However, the fact that there are so many reasons to protect biodiversity also means that we will not all address the same biodiversities.

The prescriptive nature of the notion of biodiversity is also due to the fact that is has become, since the Rio convention in 1992 [1], a legal and political concept, subsequently integrated in European and national law that the people in charge of public policy must observe (see box 1).

1. The convention declares "the intrinsic value of biological diversity", which corresponds to an ecocentric ethic. It also proposes that the "benefits arising out of ... conservation and sustainable use of biological diversity" should be used for "fair and equitable sharing" among human communities. Biodiversity is thus attributed an instrumental, i.e. anthropocentric, value.

When divided, the notion is descriptive, when taken as a whole, it is prescriptive, it is also a legal concept and an issue in public policies. As such, biodiversity concerns scientists in the various disciplines (systematicians, population geneticists, biogeographers, ecologists) just as much as environmental managers, developers, amateur naturalists, activists for environmental protection, hunters, fishers, etc.

The new scientific and technical context modifies the traditional protection goals in that the issue is no longer to protect nature against human activities. The goal is either to maintain the disturbance regime that produced the present situation, or to redirect, initiate or block, in short to manage trajectories in order to produce a situation deemed preferable to the present one (or to that toward which it would spontaneously tend).

If we succeed in managing natural dynamics, we can target various situations that are more or less favourable to biodiversity and more or less desirable for humans. Efforts to determine the environment in which humans want to live and that would grant the greatest freedom of choice to future generations thus give way to political discussions to decide which state of the world is deemed preferable from the point of view of human activities and from that of nature.

Adoption of biodiversity as a standard for action and of the various biodiversities as evaluation criteria for desirable (or feared) trajectories has important consequences for politics and environmental-protection practices (Larrère and Larrère, 2009).

Action is undertaken in view of goals that can be negotiated and combined with other goals if they can be reconciled. It can be evaluated on the basis of the observed results. We can thus leave behind the opposition between human activities and a "naturalness principle" which previously placed natural processes above change induced by human use of nature and which declared the need to protect nature from humans. That is the good news proclaimed by contemporary ecology, i.e. it is possible to be part of nature and draw benefit from it, without destroying it… on the condition that we make the necessary efforts.

We have long been concerned with "remarkable" species and areas, but the adoption of biodiversity as a positive standard is an invitation to take care of ordinary nature as well.

Finally, working in the field of biodiversity means accepting controversy and debate. Each person, depending on their goals, experience and knowledge can legitimately claim to speak for the elements of biodiversity being negotiated. We must accept debate and compromises, i.e. avoid attempts to impose viewpoints at the expense of all others. The search for compromises implies that each person understand the ideas, but also the aspirations, passions and limitations of all the other persons involved. Each person is encouraged to respect the ideas of others, without necessarily adopting them, and to abandon technocratic procedures in favour of participative approaches. ■

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▶ You can consult the bibliography on www.set-revue.fr

1 Biodiversity values in international laws and conventions

The notions of biodiversity and ecosystem services are frequently confused. For example, scientific articles often include the term "biodiversity" in the title or among the key words, whereas in fact, the article studies a biological process or an ecosystem service for instance, and not the *diversity of life forms* within an ecosystem. It is necessary not to confuse topics dealing with the diversity of life forms, i.e. biodiversity in the sense of the Convention on biological diversity (see a summary of definitions, Gosselin *et al.*, 2004) and those dealing with life itself or ecosystem services, which are more general concepts. This confusion is even less understandable given that ecosystem services are not determined exclusively by biodiversity. In fact:

– biodiversity is one of the services rendered by ecosystems, i.e. the supply of a wider resource in the sense used by Larrère and Larrère, in this issue;

– elements of biodiversity contribute to ecosystem services, but rarely does biodiversity itself do so. For example, vegetation cover is required to protect soil from erosion, but it does not necessarily have to be very diversified.

Two types of values may be associated with biodiversity.

– An existence value, by which biodiversity must be protected in its own right. The existence value is justified by immaterial aspects, including a humanistic approach which considers that all biodiversity is worthy of conservation in that it is a beneficial source of marvel for humanity, for its aesthetic, spiritual and cultural values, or as a heritage that must be transmitted to future generations, given that the loss of a species is irreversible (Larrère and Larrère, this issue). Biodiversity is, in this case, an ecosystem service rendered to humanity.

– A value that we will call extrinsic because, from this point of view, biodiversity must be conserved for a function or ecological entity other than itself, for example, its participation in ecosystem services, that may be real or potential, material or immaterial, supplied to humanity, e.g. provision of goods (medicinal plants, food, energy, textiles), regulation and self-maintenance services (ecosystem operation, predation, etc.). In this case, it is biodiversity itself that renders service.

However, it is not clear from the opinions expressed by managers, politicians and even scientists that biodiversity is seen as an ecosystem service among others and valued for its existence alone. On the contrary, utilitarian, extrinsic values often dominate. There would seem to be a major "split" between the domination of the utilitarian, extrinsic values in discussions on biodiversity and:

– on the one hand, the use of biodiversity as the exclusive standard for natural-resource policies (Larrère and Larrère, this issue);

– on the other, acknowledgement of the existence value of biodiversity as the overriding goal of numerous legislative *documents* on biodiversity (see table 1).

We clearly find ourselves here in an expanded anthropocentric (or humanist) approach, even when speaking of the existence value of biodiversity (as proposed by Gosselin (2008) as the ethical basis for ecological engineering), primarily because the international texts presented here would appear to have adopted this approach. ■

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1 Goals and underlying biodiversity values in the main international and European conventions on biodiversity.

	Ramsar convention	Washington convention	Birds directive	Bern convention	Bonn convention	Habitats directive	Convention on biological diversity
	UNESCO *	CITES **	Council of the European communities	Council of Europe	United Nations	Council of the European communities	CNUED ***
	1971	1973	1979	1979	1979	1992	1992
Is biodiversity one of the main goals?	No	Yes "wild fauna and flora in their many beautiful and varied forms"	No	No	Yes "wild animals in their innumerable forms"	Yes	Yes
Goals	• Conservation of main wetlands. • Rational use of wetland resources.	•Protect wild species against excessive trade.	• Protect, manage and regulate species and their habitats. • Preserve the diversity and quantity of habitats.	• Conserve natural fauna and flora and their habitats.	• Sustainable use.	• Protect wild species of fauna and flora and their habitats. • Encourage maintenance of biodiversity.	• Biodiversity conservation. • Sustainable use of its elements. • Fair and equitable sharing.
Values assigned to considered elements of biodiversity							
Existence value, i.e. biodiversity must be protected in its own right.	Not explicitly mentioned.	"irreplaceable value".	"common heritage".	"intrinsic value".	"irreplaceable value".	Not explicitly mentioned.	"intrinsic value".
Extrinsic value, i.e. biodiversity must be protected for reasons other than itself.	Economic, cultural, scientific and recreational value.	Economic, cultural, scientific, recreational and aesthetic value.	Social and economic value.	Aesthetic, scientific, cultural, recreational and economic value. Role in maintaining biological balances.	Mesologic, ecological, genetic, scientific, aesthetic, recreational, cultural, educative, social and economic value.	Not explicitly mentioned.	Value of biological diversity and its components in environmental, genetic, social, economic, scientific, educative, cultural, recreational and aesthetic terms.

* United Nations educational, scientific and cultural organisation ; ** Convention on international trade in endangered species of wild fauna and flora ;
*** United Nations conference on environment and development.

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