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Ensayo

TOWARDS A CULTURE OF BIODIVERSITY CONSERVATION

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RESUMEN

Este artículo pretende ser una síntesis de ideas antes expuestas por el autor sobre conservación de la biodiversidad y propuestas nuevas, inéditas, sobre el mismo tema. Una preocupación central ha sido señalar que en cada sociedad humana las ideas sobre uso y conservación de la biodiversidad y en términos más generales sobre la naturaleza, son parte de la cultura de esta sociedad y por lo tanto no pueden separarse de sus valores éticos y estéticos y de su realidad socioeconómica.

Se consideran tres grandes enfoques en relación a la protección y uso de la riqueza de especies: el uso rústico, el establecimiento de áreas protegidas y el ordenamiento ambiental. Dentro del enfoque áreas protegidas se examinan tres modalidades, aparecidas en distintos momentos históricos y como respuesta a necesidades diferentes, modalidades no excluyentes entre sí. Son éstas, los cotos o reservas de caza, los parques nacionales y las reservas de la biosfera. Estas tres modalidades tienen en común el propósito de proteger una riqueza excepcional de animales y plantas dentro de un área espacial determinada. Se examinan los problemas que enfrentan en sus planteamientos ante la evidencia cada vez mayor del recambio espacial de especies: la diversidad beta. Para proteger la diversidad beta no es suficiente un área, así sea grande. Justamente como respuesta se plantea una alternativa totalmente nueva y complementaria a las anteriores: las reservas archipiélago.
Palabras Clave: conservación de la biodiversidad, uso rústico, reservas de la Biosfera, reservas archipiélago.

ABSTRACT

This article is intended as a synthesis of the ideas, previously presented by the author, on the conservation of biodiversity as well as new proposals, heretofore unpublished. The author focusses on the central theme that in each society the ideas held about the use and the conservation of biodiversity and, in more general terms, about nature are an integral part of the culture of that society, and as such cannot be separated from its ethical and aesthetic values, or from its socio-economic reality.

Three broad approaches to the protection and use of species richness are considered: rustic use, the establishment of protected areas and land use policy. Three types of protected areas are examined: hunting or game reserves, national parks and biosphere reserves. These conservation strategies appeared at different points in history in response to different needs and are therefore not mutually exclusive. They share the goal of protecting the exceptional richness of animals and plants within a delimited area. The problems facing these approaches, given the increasing evidence of spatial exchange of species, i.e. beta diversity, are examined. A single area is not enough to protect beta diversity, even when it is a big one. In response to this dilemma a completely new alternative is proposed, one that is complementary to the three currently in use – that of archipelago reserves.
Key Words: biodiversity conservation, rustic use, Biosphere reserves, archipelago reserves

PRESENTATION

This essay is an attempt to elucidate the complementarity of previously expressed ideas (some from as long as 30 years ago), as well as new concepts that are presented here for the first time. I do not intend to present a compilation, nor a synthesis, but rather a series of personal ideas and experiences; though I have tried to provide an adequate bibliography in support of these.

It is with great affection and profound appreciation that I dedicate this essay to Professor Pedro Reyes-Castillo (Instituto de Ecología, A.C.). For more than 30 years, he has been my companion in both the design and "construction" of several biosphere reserves and their associated projects. Without his efforts and friendship – and, I hasten to add, that of "The Old Guard" of the Instituto de Ecología, A.C. – there would have been little (or no) progress in setting up the first biosphere reserves of Mexico. Present day successes mustn't consign earlier successes to oblivion.

INTRODUCTION: WHY DO WE NEED A CONSERVATION CULTURE?

I would like to begin with a quote from E.O. Wilson (1993): *"Human history did not begin eight or ten thousand years ago with the invention of agriculture and villages. It began hundreds of thousands or millions of years ago with the origin of the genus* Homo*. For more than 99 percent of human history people have lived in hunter-gatherer bands totally and initimately involved with other organisms... As language and culture expanded, humans also used living organisms of diverse kinds as a principal source of metaphor and myth. In short, the brain evolved in a biocentric world, not a machine-regulated world."*

I have titled this text *Towards a Culture of Biodiversity Conservation*, deliberately including the term culture as it represents, in itself, my taking a particular stance on the matter. In order to preserve biological diversity it is necessary, but not sufficient on its own to gain scientific knowledge about it. However, the acceptance and implementation of conservation policy involves much more than scientific knowledge. It carries a strong charge of ethical and aesthetic values, and depends heavily upon the socio-economic context in which it is proposed. This is why I speak of culture (see note 2). Different cultures have very distinct views about how to use (and preserve) natural resources (see Toledo 1989). These differences arise from the different types of relationships between people and nature. People may respectfully use natural resources or, conversely, may exploit them in order to obtain maximum and immediate benefit. When a hunter-gatherer harvests fruit or captures his prey, he expects nature to restore these resources and even takes steps to ensure their continued availability. This type of relationship continued with pre-industrial farming and animal husbandry. As agriculture has become more mechanized and the use of agrochemicals increased, this relationship has faded. The elements that determine success now are available capital, machinery, agrochemicals and good sales in the marketplace. The relationship between society and nature has deteriorated even further in the urban environment, where an increasingly large part of society is concentrated in the suburbs of our cities of the developing world, and has quickly forgotten the agricultural culture of their country origins. "We have tried to remove wildness from the context of our daily lives. We have worked to simplify the natural communities around us, hoping to make our environments more manageable, hoping to be more secure. That has not happened, for a simplified environment is ever more prone to what we call "wild fluctuations" – wild, in this sense, meaning uncontrolled or reckless." (Buhner 2002).

Under these acultural conditions the only way to restore the healthy relationship between society and nature is to make a conscious effort in education to regain an appreciation of nature, to understand once again our place within her, as well as the ties that exist and the

respect that is necessary. Since we live in a monetary economy, I believe that this new cultural vision will have to occur via a revaluation of natural products, and also of the human activities that produce and conserve them. (The most complete and current work on the conservation of biodiversity in Latin American countries addressing the economic, social and cultural factors that affect conservation is found in Primack *et al*. 2001).

No one denies that human societies have transformed and continue to change the planet, however many doubt that these transformations are in any way harmful to humans. They accept that there may be local or short term damage, but refuse to acknowledge the magnitude of regional or global disturbances.

Except for some cases, which doubtless exist, the transformation of natural landscapes is certainly not the result of a conspiracy to destroy nature. However, it is also true that each one of the changes occurs in a cultural context and that this context determines what is acceptable and what is bad. There are many, truly countless, examples of gratuitously hostile behaviour towards the environment; behaviour not condemned by the society in which they occurred or are occurring. The persecution and extinction of the carrier pigeon or of the plains buffalo in the United States didn't happen all that long ago. Let us remember that in both cases, over a period of very few years species went from populations that numbered in the millions of individuals to complete extinction (the buffalos in the United States today are the descendants of animals reintroduced from Canada). In both cases this massive destruction originated with a deliberate persecution, observed without comment by contemporary society. Let us remember in our Latin American countries how agrochemicals and other toxic products are indiscriminately used; the pyromania that razes entire forests to the ground; the indifference with which the shooting of any wild animal is regarded (wild animals do not belong to any one person!) in places where doing the same thing to a cow could cost you your life. In Mexico, not so long ago, when the country was under full modernization development, the government created the National Deforestation Program to hand over land without trees, and in many cases without any trace of organic soil (bulldozers and other heavy machinery can be very efficient), to the colonists it sent to the humid tropics. This aberration, against which several of us Mexican ecologists fought head-on, was cancelled only a few years ago. How many similar programs, governmental or private, continue on other Latin American countries?

All of the above leads me to think that even if what we could call deliberately evil behaviour towards nature does not exist, there are cultural situations (or a lack of culture, as often occurs on the frontiers of expansion) in which the transformation and deterioration of natural landscapes along with their plant and animal components , are viewed with indifference. This is part of the mirage of modernization and development at any cost that has characterized the official policies of Latin America for the last 50 years because they have taken "developed" countries as the model to aim for.

Nature is not only influenced by large scale programs. It is important to recognize that each and every day we contribute to modifying the environment. Each year hundreds, thousands of decisions that affect the environment in one way or another are made. Some of these decisions have a minute effect, others have great impact. A good many of these decisions are made to increase the income of companies, the well being of social groups, or of individuals, or in obeisance to the rituals and atavisms that form part of a cultural vision. However, we cannot ignore the fact that many other decisions are made through inertia,

ignorance or simple stupidity. In the first group of decisions we could include building a new house, a new road, a factory that creates jobs, a sawmill that uses part of the forest, the excessive use of fertilizer that we believe will guarantee a better harvest. In the second type of decision, among many others, are acts such as tossing plastic containers on the side of the road, dumping unwanted insecticide into a neighbouring stream, starting a fire out of carelessness or deliberately. Since the majority of each of these actions alone has a small effect that only becomes a large effect through a diffuse and disperse process, nobody feels responsible for what is occurring.

In the search for what determines the type of relationships that exist between society and nature, between society and biodiversity, an aspect that is often overlooked is that one of the functions of culture is to define what is acceptable to its people and to the rest of the world and what is not. Relationships with the environment, with living beings, with the earth, with the water are all part of our culture. The term culture embraces our visions and our ideals about the environment and about ourselves. As such, it also includes the way in which we satisfy our need for the things that we consider indispensable or that make our lives pleasant, but it also includes in a very marked way, our aesthetic appreciation, and along with that what we like and what we reject. Furthermore, it is difficult to define the set of elements that constitute cultural knowledge; starting with language. The words we use and the way in which we use them are not only derived from what we have acquired through formal learning, but also from all that we have experienced and that which has been transmitted to us in one form or another by the social group to which we belong.

Given that the modification of our natural surroundings is a process that ultimately depends on what each and every one of us does, in order to understand it we must examine why individual and collective decisions are made; those considerations that motivate us and those that make a decision either acceptable or result in its rejection. Although data on how many hectares are eroded every year, or estimates of how many species disappear, or how many tons of garbage are produced each day in our big cities all help us to understand the degree of impact, they are of little help in understanding the causes.

Ricardo Rozzi (in Primack *et al.* 2001: 311) comments on the relationship between ethics and the conservation of nature: “Environmental ethics represents a crucial dimension for biological conservation, given that the origins of the current environmental crisis are rooted in the fact that the way we related to the natural world has been established by industrialized society”.

Much of what I am going to present concerns the conditions in tropical countries (and therefore, the conditions in a good part of Mexico); conditions that I consider distinct to those of temperate countries. The difference is found not only in the biological but also in the socio-economic aspects: temperate countries have developed industrial societies, while the tropical world is comprised of everything from searing conditions of poverty to affluent societies of inequality, a complex situation referred to as “developing”, that is difficult to analyse.

Human demography is also totally different in temperate and tropical countries (even exhibiting contrary tendencies; see Toledo 1989; Tudela 1999; Alcorn 1991). If one wishes to preserve tropical biological diversity, it is necessary to find measures that are feasible in real situations, measures that guarantee the protection of diversity both now and in the medium term. Any measure that does not take into account the growing poverty of the rural

population, and the disintegration of its traditional socio-populational, cultural and ways in which consumer goods are produced – with their accompanying migratory movements and demographic increase – is of no use. These are all elements that definitively influence what happens to biological diversity. In order for good intentions (a policy for the rational use and conservation of biodiversity) to go further than rhetorical declarations, it is necessary to form an understanding based on real information obtained *in situ* regarding the ecological, economic, social, cultural and political scenario in each region.

All societies need to use their natural environment and this use implies changes. However the vision of the rights and needs of the common citizen of industrialized societies (or those that are on the road to industrialization), the position of the consumer, demands a profound change to nature with the simplification of processes and components that assure maximum productivity and financial return in the short term. This is not the aim of the consumer, although this idea dominates everyday rhetoric. The position of "indifferent owner" is not new to the relationship between man and nature, but never before has its effects had such capacity to cause deep and planet-wide changes, as well as a considerable loss of biodiversity. In spite of this, at present the vast majority of the surface of the planet and the seas surrounding the continents is thankfully used according to rustic practices.

THE CONSERVATION OF BIODIVERSITY AND THE RUSTIC USE OF NATURAL RESOURCES

I am not using the word rustic to imply clumsy or inefficient use. I am using it in contrast to intensive use. In part, although not totally, I use it as an equivalent to traditional use, especially in those cases where the use of natural resources is rooted in a truly ancestral culture.

In practice the distinction between rustic and intensive use is not always clear cut. Between the two extremes there are many intermediate forms. Efficiency should not be used as a parameter as it is possible (although for different reasons) to be inefficient in rustic practice or intensive exploitation. The fundamental difference is in the vision that the usufructuary has of his objectives. *Rustic use* implies a heterogeneous vision of the landscape. Different plants are grown. Agriculture is carried out hand in hand with raising animals and the use of wild resources (wood, hunting, fishing, gathering). The use of agrochemicals is limited or null, as is the use of heavy machinery and fossil fuels. In contrast, human labour is at a maximum, even at the expense of economic efficiency. Family, communal and cooperative businesses dominate, however, these businesses do not routinely resort to external financing. Harvests are sold in local and regional markets (many of the products being sold for family use), though products of special value may be exported. The goal is stable, long term production that maximizes the next harvest.

Intensive use has as its goal maximum yield in the short term (even per harvest), with the massive use of fertilizers and anti-parasitic chemicals, as well as machinery, combustibles and financial credit. This type of exploitation tends towards the monoculture (not only of one plant, but rather of a single variety) and vast homogeneous expanses of land. Harvests are destined for the world market.

Evidence of what we might call the friendly relationship between rustic use and the conservation of biological diversity can be found in the fact that this type of natural resource

use has allowed a world rich in biodiversity to survive to present day. This is what Alcorn (1991) calls "archaic conservation". We mustn't forget that rainforests and other tropical ecosystems are not devoid of human populations and that these populations make use of the biotic resources. Pimentel *et al.* (1992) cite the impressive example of Java where small scale farmers grow 607 species in their garden-orchards, a level of diversity comparable to that of a deciduous tropical forest.

For local populations with a strongly rooted culture, biodiversity is a basic component of the natural world in which they live, and from which they live. The reasons given by some sectors of urban society for the conservation of biodiversity often seem incomprehensible to these populations. They have lived for centuries using and interacting with the nature that surrounds them, so why should its conservation exclude their activities?

Regarding Latin America, Ricardo Rozzi comments (in Primack *et al*. 2001: 312): *"... the majority of current biodiversity is found in indigenous territories and not in the most developed regions (Alcorn 1994). Nevertheless, the capacity of the indigenous inhabitants to preserve their natural resources is frequently underestimated, and judged as primitive, poor, or as belonging to the 'Third World.' From an ethical point of view, such a dismissal constitutes unjustified discrimination which promotes the exclusion of local populations and allows for the control of natural resources to be assumed by the political and economic elite."*

Under any circumstances the conservation of biodiversity implies some degree of restriction on the use of resources. Restrictions under which individual short term interests are limited by the interests of the group or of society in the long term. In traditional societies this is implicitly understood and the rules for resource use are based on experience handed down from generation to generation and form part of the culture of these human nuclei, including their social organization and their religious convictions or rituals.

In academic circles in recent years there has been growing interest in terms of understanding, valuing and even collaborating with the traditional groups that practice conservation through resource use, and in searching for legal and economical alternatives to protect their production structures. For Mexico, see for example Toledo *et al*. (1985), Toledo (1990), Rojas (1990), Gómez Pompa *et al*. (1993), Boege & Barrera (1993), Leff & Carabias (1993), Toledo (1994); for the Amazon see Posey (1983), for the American tropics see Oldfield & Alcorn (1991), Primack *et al.* (2001); and in general, see Altieri & Hecht (1990), Redford & Padoch (1992). Primack *et al*. (2001, part six) include a series of examples of rural experiences. Some of these researchers try to support rural reserves, extraction reserves and other types of associations that seek to make conservation through use both profitable and lasting. In Mexico there are several interesting, though not conflict-free examples, such as the indigenous associations of the region of Los Chimalapas, and several producers associations on the Yucatan Peninsula. There is great interest in making rustic use more productive without sacrificing its most distinctive characteristics (see Pimentel *et al*. 1992; see also note 3).

In any case, something that those of us who are interested in the conservation of biological diversity must never forget is that now (and in the future) the majority of the world's biodiversity is not found within protected areas, but rather occurs in the landscapes that are used by man. This does not diminish the importance of protected areas, but it does highlight the importance of what is occurring outside of them.

The survival of the conservation associated with rustic or traditional resource use is put at risk by:

1 the massive change triggered by the contact with consumer societies that have abandoned traditional forms of exploitation. The greater demand for external goods (often obtained at exorbitant prices) puts greater pressure on biological resources and increases the surface area being actively exploited.

2 the ownership of the land, as this determines its use and the use of the biological resources found on it. Traditional groups and their forms of ownership (oftentimes collective or cooperative) have trouble resisting invading colonizers, and the pressures of expanding large-scale ownership (see notes 4 & 5). For a review of the threats to biological diversity see the second part of Primack *et al*. (2001).

HISTORICAL AND CURRENT STRATEGIES FOR THE CONSERVATION OF BIODIVERSITY

Through the processes of mutation, recombination and genetic isolation, as well as adaptation to different environmental conditions, all living beings tend towards diversity. If evolution is an essential characteristic of the living world, diversity is the principle consequence of evolution. In contrast to the natural world, the social world - our world - tends to simplify systems in search of efficiency in the production of goods. The dominance of increasing efficiency leads to homogeneity. Homogeneity destroys diversity. The loss of diversity is an inevitable consequence of acquiring greater thermodynamic efficiency at the expense of complexity in the components and processes of the system.

From the beginning of agricultural activity, humans have pulled out weeds to benefit their crops, effectively reducing diversity for the benefit of the plants in which they are interested. Between the demands of the natural world and the social world, at the heart of the matter we find the politics of conservation and, as with all complex problems, there are various solutions that lead to different scenarios in which one or another of the elements in play are optimized.

The different strategies for conserving biodiversity can currently be placed in one of the three following general proposals: I) rationalize and protect conservation with economic measures through the type of rational use previously mentioned, ii) establish protected natural areas or for some species, establish germoplasm banks *ex situ*, iii) dictate the use of space for large tracts of land.

It has been indicated (McNeely *et al.* 1990) that behind all the actions affecting biodiversity one can find an inequitable distribution of costs and benefits, for both the exploitation of the biological resources and in the conservation of biodiversity. Those who receive the greater part of the benefits of exploitation do not pay the costs of conservation. Those who bear the brunt (or who end up bearing the brunt) of the costs, receive very few of the benefits. As mentioned, the matter is complicated by the different perceptions of diversity held by urban populations that include the richest sectors of society and rural populations.

PROTECTED NATURAL AREAS

I am going to deal with four types of protected natural area. Three of these have been developed at different points in history and in response to different socio-economic scenarios. The fourth type of area is a new perspective that I am working on and promoting: "archipelago reserves". As has occurred with scientific proposals in the past, these ideas and the understanding of the need for this type of area are "in the air", so to speak. This new type of protected area addresses a need that more and more people are becoming aware of as time goes on.

There is a notable difference between the first three types of protected natural area and the archipelago reserve. The first three, in spite of the great differences between them, were conceived to protect high local species richness or, when large expanses of land were involved, a landscape rich in species. That is, to protect the richness of a certain area. The archipelago reserves have been conceived in response to beta diversity; that is, in attention to the exchange of species across areas. As such, "under the same umbrella" they would cover a variety of spatial units with a discontinuous distribution. It is worth mentioning that under this conservation strategy none of the different types of reserves are excluded, but rather complement each other. There are landscapes in which local richness dominates and that therefore require biosphere reserve type areas, and others where there is more spatial exchange of species between places that are not necessarily rich in species in their own right and where, thanks to this exchange, there is an important number of species on the regional scale. It is in these cases where archipelago reserves are the way to go.

The first generation of protected areas identified by the generic term *game reserve* came about as a response to the needs and desires of the owners of great tracts of private land (a distinct minority in the population) who wished to guarantee for themselves not only an adequate supply of meat (when beef was scarce), but also their supply of other biological products such as the high quality wood that was indispensable for the construction of houses and ships. Doubtless, they also desired a place where they could carry out what might have been their main activity: the hunt. In western Europe these areas, forests and marshes – both of which were extensive – were associated with the way of life and privileges of the royal families and the feudal aristocracy between the 10th and 18th centuries. In the period of its greatest power the Plantagenet family (late 12th and early 13th century), kings of England and landowners of huge feudal domains in France, were the direct owners of more than half of England; an area that was preserved with laws and measures that were not only severe but also cruel, and that was destined exclusively for hunting game and exploiting the forests (Rackham, 1998). This situation even led to limitations in agricultural and sheep production (see note 6).

The second generation of protected natural areas is represented by *national parks*. The first to be created was Yellowstone (1876) in the west of the United States. The objectives of this second generation were different from those of the game reserves. These parks were created – in reality imposed – by urban society. Their aim is to preserve natural spaces, wild spaces for tourism and recreation. Tourism was a new activity that quickly expanded with the railways starting in the second half of the 19th century.

National parks based on the North American model exclude all human activity except tourism. In many cases local populations were even expelled or at the least restricted in their

use of the natural resources. These parks are managed by a central administration that is more bureaucratic and restrictive than innovative; an administration that has no interest in making conservation compatible with development. Beyond the limits of the park intense development continues unbridled. Although the national park system was successful in some large industrialized countries (especially the USA), and in some European colonies during the first half of the 20th century, in many countries this system never worked well and with increasing population pressure it reached its functional limits. In the majority of cases the problems and limitations were caused by not taking into account the needs and ideas of the local populations. *"The administrators of parks the world over consider conflicts with the local communities their most serious problem... When the park provides benefits for the local community in terms of employment, sharing of income and regulated access to natural products, then the community can accept and support the park. However, when a new park is created or when the limits of an existing park are rigidly controlled, those who have traditionally used a resource can be denied access."* (Primack *et al*. 2001: 588-589). Not taking into consideration the rights and practices of the local communities is tantamount to a form of eco-colonialism.

It is in this context that the *biosphere reserves* are born. The idea appears and is developed in UNESCO's Man and the Biosphere Program (MAB). It is possibly the most innovative contribution to the conservation of nature ever made by an organization of the United Nations (see note 7).

The first list of biosphere reserves was established in 1976. The concept and the form for its development was definitively consolidated with the Seville Strategy, presented after a major conference held in this Andalusian city in 1995, and formally approved by all member countries of UNESCO.

The biosphere reserves arose from a proposal made by the international scientific community. As such they proposed the specific characteristics of these reserves right from the beginning: they must 1) form part of an international network, the components of which are complementary, 2) include within their objectives both basic and applied research, 3) seek the zonation of those reserves that cover great expanses, as well as promote the coexistence of different activities, 4) apply the strategy that promotes biosphere reserves, taking into account that the conservation of biodiversity does not imply not using it, but rather using it in a sustainable way both that apportions benefits today, and maintains the resource for future generations.

In the beginning, for some countries that had an extensive and consolidated parks systems such as the United States, the acceptance of the biosphere reserves was not perceived as a change, but rather as a name change for some of the larger parks that did not imply any important change in their management or their objectives (this situation has changed in very recent years). In other countries, as is the case with Mexico where the parks system was not working, the biosphere reserves represented a new possibility. Some research centres such as the Instituto de Ecología, A.C. took them on in order to promote and experience a new type of protected area more in line with the social and ecological reality of Mexico (see Halffter 2002). The innovations that were implemented for the first time in Mexico have been incorporated, along with the fruits of experience from other countries, into the general strategy of UNESCO that came together in the Seville Strategy. An excellent analysis of the history, activities and management of a biosphere reserve, that of Manantlán, is presented in Graf *et al.* (2003).

The guidelines developed in Mexico emphasize the importance of complementarity between biosphere reserves and national parks, rather than competition or substitution. National parks are smaller in general and tourism represents an important activity in them, while biosphere reserves are generally much, much larger and, without sacrificing the conservation of biodiversity as their primary objective, they have additional objectives. Scientific research is very high on this list; research both dedicated to solving basic problems in ecology that require experiments carried out over long periods of time, and studies that further our understanding of the flora and fauna, as well as sustainable ways to make use of their biological resources. The participation of local populations and non-governmental organizations (NGOs) is sought for both the management and the administration of the biosphere reserves. Through debate, the formulation and acceptance of management programs that dictate what can and cannot be done in these areas, and of advisory councils, in which members of the local population participate, have been very important mechanisms for collaboration (these ideas, known as the "Mexican Modality", were conceived and developed in Mexico. See Halffter 1984). In a recent review of one of the Mexican biosphere reserves in which much work has been done, Jardel *et al.* (2003) presents the difficulties represented by the restrictions inherent to the establishment of a biosphere reserve (especially the nucleus areas), and the needs and responses of local populations.

In most cases, the size of biosphere reserves and their zonation makes it possible to dedicate spaces to the search for different types of sustainable development that allow for the use of the biological resources without putting their continuity in danger.

If the biosphere reserves are fulfilling their mission successfully in a good part of the world, why propose a new type of protected natural area? The following subchapter is dedicated to this question.

Current problems facing the system of protected natural areas

Although in some countries biosphere reserves have begun to represent a new alternative for conservation, in the majority of the tropical world – even though there are exceptions such as Costa Rica, some cases in Mexico and one or two other countries – protected areas established by the government represent a space that is set aside and excludes the local populations from any economic benefit. This exposes these areas to demographic ("antlike" trickle invasions) and economic pressures (illegal extraction of some of its more desirable resources) that, at least in part, place its integrity at risk. This, not to mention the appalling violations that occur when the petroleum or mining potential of a protected area is detected, or when the area falls within the interests of some important (and usually politically well connected) company. All the biologists of my age have, on several occasions, seen scenes like that depicted in the slide that the great botanist A.H. Gentry liked to show of a protected area in a South American country with a huge sign announcing the protected status of the area and listing the many activities that were forbidden. Behind the sign, as far as the eye could see was a sea of the tree stumps that remained after a clear cut and in the foreground a group of forlorn looking children.

The problems that I mention have always existed. Perhaps, taking a balanced view, even though the situation is not perfect, in countries like Mexico the protection of natural areas has improved markedly and steadily in recent years. The problems that I mention below are

different, and although they existed even then, were not perceived thirty years ago when we began the international movement to promote biosphere reserves.

In the first place, it is increasingly evident that many, many species live outside of protected areas. We can take as an example, that mentioned by Pimentel *et al.* (1992). In Kenya, one of the countries with the greatest area of national parks (7% of the country's surface area), approximately three quarters of the mammals and 90% of other species of animal live outside of the parks. According to Rosenzweig (2003) no more than 5% of all species live within the protected areas of the world.

There are other types of reason as well. Recently, several authors (Angermeimer 1999; Robertson & Hull 2001; Broocks *et al*. 2002; and Salafsky *et al.* 2002) have indicated that the formal creation of more and more protected areas (that in many cases are often not protected by anybody) is clearly not the solution to the problem of how to preserve biodiversity unless, at the same time, there are changes to the funding policies and relationships with local populations.

One reason, and it is one of deep ecological significance, makes us think that a system of conservation like the current one can never protect a sufficient portion of the tropical biota, especially in mountainous regions. The design of biosphere reserves gave rise to a conflict of scientific opinion (dealt with in the next chapter). After heated discussion, the idea that the best reserves would be large and preferably round prevailed. This position was clearly derived from MacArthur and Wilson's ideas about island biogeography: a greater area implies a greater number of ecological niches and therefore a greater number of species. There is little doubt that under certain ecological conditions, such as those found on islands and those in the enormous temperate zones of the northern hemisphere, the assumptions set out by MacArthur and Wilson are met in general terms. We could simplify this by saying that under these conditions in the best places we find high alpha diversity that explains the majority of total species richness of the landscape. In other words, the distribution of species is highly nested. Protecting these privileged spaces and ensuring the continuity of their ecological processes was a logical strategy and one that was congruent with the protection of biodiversity.

But in recent years there has been an increasing number of studies demonstrating that in certain tropical landscapes, especially mountainous ones, sites with particularly high alpha diversity are scarce (see the next chapter). In these landscapes there is a high, and even very high, exchange of species between places. Beta diversity is high. This exchange occurs even though taxonomically close species occupy the same functional dimensions. This high beta diversity is the origin of the ample number of species found in the landscape that characterizes some of these places – a number of species that corresponds to the entire area, but not to any one place in particular. How can this diversity be maintained by a protected area that is different from current ones? We will try to answer this question in the next chapter.

ARCHIPELAGO RESERVES (see note 8)

The answer is archipelago reserves. These are not a substitute for the biosphere reserves. What I am proposing is a complement to the current types of protected areas; a complement especially appropriate for those regions with high beta diversity, such as the Transverse Volcanic System of Mexico.

What would the structure of an Archipelago Reserve be?

In no way are the archipelago reserves conceived to compete with the biosphere reserves. In the first place their administrative structure should be much more flexible. Furthermore, their creation is only justified in those landscapes where beta diversity dominates.

In many regions the creation of more conventional protected areas (even biosphere reserves) could lead to conflict with the need that the local population has to use biological products and the land. However in these regions, including those that have a large human population, there are already national parks, often small or medium-sized and almost always neglected, as well as private reserves, communal and municipal reserves, or other areas that can be acquired. The important thing is to know whether, in these landscapes, beta diversity is the main determinant of total species richness. It is also important to know whether fragments have a greater richness of species. There are several methods for achieving this, among which useful ones include those that consider phylogenetic information or singularity, such as the ones based on nodes (Vane-Wright *et al*. 1991, May 1990), methods based on genetic distance (Croize 1992, 1997; Faith 1994a) and those based on character richness (Faith 1992a, b, 1993, 1994b, c), any other type of method based on phylogenetic singularity and those that, as is the case of the work by Posadas *et al*. (2001), additionally use endemism. On the other hand, we could do an analysis of complementarity to determine which area contributes more species to the total, which contributes the next greatest number of species, and so on. It may be that we cannot have within our system of protected areas all of the most representative fragments, especially if we make use of the existing structures. However, we can expect to obtain a highly complementary set of areas. This collection of sites is what we need to protect with a legal and functional "umbrella": the Archipelago Reserve. Special care would be taken that this "umbrella" not restrict the activities of the surrounding areas, except in the search for corridors of continuity (connectivity), and promotion of a culture that would gradually take on the mantle of conservation, making it part of the people's mind set and promoting certain economic benefits and improvements to the quality of life.

One very clear example of this is given by Rodríguez *et al*. (2003): *"The analysis of complementarity demonstrated a clear relationship between the minimum number of sites necessary to complete a fauna and the patterns of beta diversity. The region with the greatest exchange of species (central Mexico) would require a high number of 0.5 x 0.5 degree quadrats in order to protect all of its terrestrial mammalian fauna (10 quadrats). In contrast, on the Yucatan Peninsula... three quadrats would be sufficient to protect all of the terrestrial species of mammal in the area."*

I will examine, one by one, the biological reasons for the creation of archipelago reserves. I will also address political and social reasons, given that I have indicated time and again that the conservation of biodiversity is much broader in scope than its purely biological aspects.

Biological reasons: Precedents

It is possible to follow the path of influence of the Theory of Island Biogeography in the design of protected areas since Wilson & Willis (1975) and Diamond & May (1976). The reasoning is that if it is possible to protect a given space, it is preferable to create one large

reserve, rather than two or more small ones. From its origins, and up to now, this has been the position of MAB-UNESCO. The reasoning being that reserves function as islands that maintain a chunk of the ecosystem intact and a large one has more species than two or three small ones.

Criticism of MacArthurian ideas, headed by Daniel Simberloff, began at the end of the 70s (Simberloff & Abele 1976). Arita and Rodríguez (2001) give an excellent account (with a rich bibliography) of the passionate controversy that followed. Simberloff & Abele (1976) criticized some of the recommendations for the design of reserves based on island biogeography. Contrary to the recommendation to favour a single large reserve instead of several small ones, they demonstrated that under certain conditions it was preferable to have various small ones that, together, could house more species than a big reserve. And so began the SLOSS controversy ("Single Large or Several Small") that, in addition to other things, gave rise to an important confrontation of ideas (Soulé & Simberloff, 1986) which led to the conclusion that the theory of island biogeography made no significant contribution to the design of areas for conservation and that in order to provide a specific recommendation it was necessary to have additional data not taken into account by the theory.

Biological reasons: A current vision

The total diversity of an archipelago reserve is the sum of the alpha diversities of each of the areas in it. The total diversity of this sum increases with increasing difference in the lists of species for each particular area (as they are increasingly complementary). While alpha diversity is associated with local environmental factors and with the interactions between populations (in particular, intraspecific competition: the classic ideas of Hutchinson and MacArthur's school of thought), beta diversity is determined by the heterogeneity of the landscape, and even by historic elements that we are only beginning to explore. For Mexico, Arita & Rodríguez (2001) give an excellent example of the relative importance of both types of diversity. At the local level, in general, Mexico is not particularly rich in species. For example, according to these authors even the area in Mexico with the highest biodiversity, the Lacandona Rainforest, has a number of terrestrial mammals equivalent to that of other comparable locations in the Neotropical region. Additionally, the bat fauna of the Lacandona Rainforest (comprised of 64 species) is less diverse than that of other locations, such as some in British Guyana, where up to 78 species coexist.

The political entities of Mexico are not particularly rich in species when compared to equivalent political entities elsewhere in the tropical Americas. So, how can Mexico be classified as a country of megadiversity if neither its sites nor its states are particularly rich in species? The answer lies in the beta diversity. Mexico, compared to other countries of the American Continent is a country with average alpha diversity, but high beta diversity. And it is the latter that makes the gamma diversity so high. This is clearly expressed in Arita & Rodríguez (2001) and Rodríguez *et al*. (2003). "*In Mexico, owing to the high degree of species exchange it is much more desirable to establish a system of many medium sized and small protected areas, than a system of few large areas*", an opinion previously expressed by Arita (1997) and Scott *et al*. (1999).

Mexico is a betadiverse country (see research by Arita, also Rodríguez *et al*. 2003), but as expected in a country of such size, environmental and geographic variety beta diversity is not uniform throughout the country. It is very high in the orographic systems – especially in the Transverse Volcanic System (see note 9).

According to Munguía (2004), the mammals of the Transverse Volcanic System are widely represented in the established protected natural areas. Nevertheless, in these areas more than 50% of the natural vegetation has been altered and exhibits a high degree of fragmentation. Additionally, these areas are generally small and isolated from each other. Munguía (2004) proposes the establishment of networks based on protected natural areas with corridors between them, analysing:

1) Complementary areas, under the principles of endemism and richness, to ensure the protection of the greatest number of species.
2) The establishment of corridors between the complementary areas to favour long term survival.
3) The calculation of beta diversity indices for the Transverse Volcanic System, for non-endemic species, endemic species and microendemic species.

Munguía's proposals perfectly match the conceptual framework upon which I base the creation of archipelago reserves. Munguía proposes the creation of three high priority networks in the Transverse Volcanic System, covering the Western Region, the Central Region and the Eastern Region. The importance of the Transverse Volcanic System to biodiversity in Mexico is enormous. According to Munguía (2004) this system is home to 72% of the genera and 79% of the species of terrestrial mammals in Mexico, with a total of 137 species, nearly half of which (68 species) are endemic to Mexico. Of these, 21 are limited to the System and many of them have a restricted distribution.

How should the areas of an archipelago be selected?

An efficient mechanism for determining which areas should be selected is the analysis of complementarity. The purpose of this analysis is to protect the greatest possible number of species in the smallest number of sites. A useful algorithm for selection uses the complementarity of species between sites (Vane-Wright *et al.* 1991). Two sites are increasingly complementary to each other as a greater number of species is found in one but not the other. The analysis of complementarity shows the direct relationship between the number of sites needed to represent the biota and patterns of beta diversity.

Social and political reasons

There are other types of reason for thinking about the current convenience of archipelago reserves, and these are social and political reasons. The System of Protected Natural Areas of Mexico, in spite of its undeniable progress, does not guarantee the conservation of the beta diversity of the large mountain ranges. Many of the National Parks (generally small in size) could contribute to preserving this biodiversity but they have had a difficult history. In many cases they are in quite a state of deterioration. The majority lack a functional structure. The required funding and personnel are lacking. The reserves created by municipalities, social groups, academic institutions or private citizens are also subject to strong pressures. It is for each and every one of these areas that archipelago reserves can serve as an "umbrella". An umbrella that protects them, without requiring that they sacrifice their identity or special characteristics.

It is essential for each archipelago reserve to be provided with a small operating structure (which could be a non-governmental organization) charged with obtaining and helping in the budgeting of funds for conservation activities, with publicizing the objectives of the protected areas throughout the local populations of the region, and promoting those benefits that can be obtained (from, for example, ecotourism) without affecting the basic mission of conservation, as well as providing legal and technical advice.

The aim and reason for the archipelago reserves is to give the small and medium-sized conservation areas of a specific regional space, the support that ensures the continuity of biological richness – continuity that, owing to lack of funding and infrastructure, these conservation areas cannot guarantee by themselves. This also includes the proposal and encouragement of biological corridors that stretch between areas, as well as the rustic use of the land that favours connectivity between the areas. Finally, another aspect of the aim includes studying the convenience and the possibility of complementing the existing areas with proposals for new ones.

LAND USE POLICY

Land use policies require an exercise which geographically locates the species richness (as well as the assemblages in which this richness occurs), and involves an analysis of what activities can and cannot be carried out in different places. This type of study allows us to determine which actions are acceptable by modelling alternatives and comparing the scenarios and their end results. Land use policy is not only an intelligent instrument of politics (it is truly the only one that allows us to compare alternative strategies), it also offers the opportunity for the population of a region to be involved in the decision making process for their environment. A study that is properly done should include explanations that are sufficiently clear (and, of course, scientifically well founded) regarding what would happen in a given landscape if one, another, or a different policy altogether were followed. It provides an analysis of alternatives for policy makers that allows them to select and plan a strategy of land use in the full awareness of the costs and risks involved, without the need to respond hastily or bend to popular opinion. With respect to the citizens of a region, the land use policy replaces the naive, often emotional call to action (and/or publicity stunts) directed at the conservation of a few symbolic species, a call that undoubtedly is well intentioned, but that is also characterized by meagre reflection on the costs and limitations involved. A land use policy that has been accepted by the population is the best way to support conservation in protected areas and to relate it to what is going on around it.

Land use policy allows for (a) coordinated management on the scale of landscape, transcending the limits of property ownership and the diversity of use, (b) the application of ecological, economic and social principles in the support of long term conservation, c) an intensification of the involvement of different social groups in the tasks of conservation, (d) the establishment of monitoring programs, as well as (e) the development of programs for regeneration and restoration.

CONCLUSIONS

If we wish to have a certain degree of success in the conservation of biological diversity, I feel the following points must be taken into account:

- We must be clear about what we wish to preserve and be willing to assume the social and economic costs that this conservation represents.
- We must put proposals for new protected areas into action, as well as proposals for existing areas, especially with social consensus so that they can be implemented.
- The economic and social situation is a determining factor for the conservation of biodiversity. The policy of conservation should have an integral approach that takes biological, social and economic aspects into consideration together.
- The conservation of biodiversity should be considered a modality for the good management of natural resources developed using regional land use policy.

There are two distinct visions of the goals of conservation and each depends on the idea that we have of what a community is in ecology. In the first vision, we try to preserve pristine samples of the biodiversity of different types of community in protected areas. This position is contradicted by a large body of evidence: beta diversity makes it very difficult to have representative samples of the entire species assemblage of a landscape; it is not possible to detain the processes of climatic change, it is not possible to attain satisfactory conservation under conditions of isolation, etc. Even so, this position is sustained in the majority of official discussions and in many of the arguments presented by environmentalists owing to its congruence with the supposed paradigm that the community is a real entity with a fixed species richness.

According to the second vision, conservation that is based exclusively on protected natural areas is not sufficient given that, in principle, this policy only assures (in the best case scenario) the continuity of a limited portion of the total biodiversity. For the majority of biodiversity to be preserved, it is necessary to emphasize complementary policies such as land use policies, the sponsorship of rustic use, and the provision of economic incentives for treating the environment in a friendly way, all measures that are in line with a global policy.

Some of us have proposed that there are types and degrees of human activity, the effects of which are not detrimental to biodiversity, but rather contribute to maintaining a rich maximum of species in the landscape under conditions of moderate disturbance, and to reducing the social and economic pressures that threaten protected areas.

We also accept that there can be changes in protected areas (from the effects of global change, to the impact of fire and cyclones). Rather than avoiding these changes (which is impossible) we should try to limit their impact in space and time when it is clearly human in origin.

Ideally we would engage in the serious study of whether a certain type and degree of human activity is not only harmless to diversity, but to the contrary also helps to maintain a diversification in the processes of the species assemblage. Above all, it is necessary to try to avoid “freezing” biodiversity and analyse the free play of the processes of the assemblage (processes of which we only have a limited understanding), observing in which cases we can act to maintain the dynamics that approximate the situations that we deem most important.

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NOTES

1) Part of this text was presented in a conference held at the National School of Biological Sciences (IPN), Mexico on March 19, 2004.

2) Some of the ideas discussed below have been previously presented in collaborations with colleagues, see Halffter *et al.* (1999).

3) Under the general heading *"The development of sustainable agriculture and the protection of biodiversity are not two different undertakings, but allied aspects of conservation as a whole in the humid tropics"* see National Academic Press, Washington, D.C. 1993. A review of the topic can be found in M.L. Oldfield & J.B. Alcorn, 1991.

4) In the Amazon, *"The forest destruction now at hand might have been tolerable if the replacement land uses –agriculture and pasture– were sustainable. As it stands now, agriculture and pasture are but short moments of production in a larger process of degradation"* (Hecht, 1992: 38).

5) Large scale cattle ranching. Of all the changes the Latin American tropics have undergone, the most brutal have been produced by raising cattle. Although it is not an activity that generates a high economic yield per unit area, ecologically it is an intensive activity that results in profound modifications to the landscape. Few types of production provide a more stark contrast with the traditional heterogeneous use of the land than extensive cattle ranching. The process of transforming land to raise cattle has been analysed for various locations. For example, in the state of Veracruz, Mexico (where cattle have been pastured for ages) the pastures created increased from 21.6% of the surface area of the state in 1940 to 50% in 1993. This expansion has occurred at the expense of tropical forests and traditionally cultivated land (see Barrera and Rodríguez, 1993; Rodríguez & Boege, 1992; both books with an extensive bibliography. For the Amazon see Hecht, 1992). Not only does raising cattle result in a drastic reduction of the forest (and convert its remnants into true islands), it also affects the rural population as, little by little, these people are divested of their lands, their resources and their traditional ways of life. As many authors have indicated, the large scale raising of cattle has developed to satisfy the growing demand for cheap beef in industrialized societies – a demand associated mainly with the United States, but that also exists in the large cities of developing countries. The local beneficiaries constitute a small minority given that one of the most negative characteristics of large scale ranching is that it creates very few jobs. According to Hecht (1992: 382), in the Amazon only one permanent job is created per 1 000 hectares. This type of job market effectively results in the exile of the rural population to the cities, and also creates a tense atmosphere of local violence.

6) It is not common to put a comprehensive value on the conservation of biodiversity achieved through game reserves and feudal forest reserves. After the centuries of intense transformation of the landscape in the name of agriculture and animal husbandry carried out by the Romans and the Romanized interests that devastated entire regions of the Mediterranean, the decrease in population and the interest by those in power in hunting and logging or woodsman ship represented a long reprieve for forests and marshes. For the kings and lords the hunt and the bounty of their landholdings was jealously guarded evidence of their status. They were, of course, also a source of meat which was an indispensable food (the *companagium*) in a monotonous diet based on bread. Additionally, the forests provided the huge tree trunks that were indispensable for building and furnishing houses, and in the construction of ships. It is not often in the history of the relationship between society and nature that cultural and symbolic aspects have been so tightly bound with the

practical needs of a single class, as that which occurred during the Middle Ages (and to a lesser degree until the 18th century) through the strategy of forest and marsh use employed by the European aristocracy. These strategies clashed with the rest of the population's need to obtain food, and are even distinct from the interests of another large group of landholders – the monasteries and churches that, via intermediaries, had their land under cultivation (on these topics the books by Georges Duby, 1976, 1977 and Martin Aurell, 1966 and 2003, all of which have ample bibliographies, are recommended to the curious reader).

With the fall of feudal power the great game reserves fell into crisis. The French Revolution guaranteed all citizens the right to hunt, seeing in the forests wood to be converted into money and, in the marshes only swamps to be dried out and reclaimed as land. The Convention, the great legislative instrument of the Revolution, gave rise to the conversion of the forests of the nobles into useful crops. The effects of this new vision were immediate: the modernization of land use was accompanied by a great reduction in the area covered by forests in France and the disappearance or extreme local restriction of species during the 19th century and the early 20th century.

7) Currently, the International Network of Biosphere Reserves includes 440 reserves in 97 countries.

8) I first presented the idea of Archipelago Reserves at the September 29, 2003 session of the National Council on Protected Natural Areas, held in Mexico. Thanks to support from the Fund for Protected Natural Areas of the Mexican Fund for the Conservation of Nature and the Instituto de Ecología, A.C., on the 17th of October, 2003 it was possible for a group to meet in Xalapa, Veracruz to discuss the idea and highlight the importance of beta diversity. This group was comprised of Gonzalo Castillo, Reneé González, Enrique Jardel, Daniel Piñero Dalmau, Victor Sánchez Cordero and the author, as coordinator.

9) The main studies that refer to beta diversity in Mexico (and this is not an exhaustive list) include: Arita & León Paniagua, 1993; Toledo, 1994; Sarukhan *et al*., 1996; Arita, 1997; Arita *et al*., 1997; Ceballos *et al*., 1998; Rodríguez, 1999; Arita & Rodríguez, 2001; Moreno & Halffter, 2001; Arellano & Halffter, 2003; Rodríguez *et al*., 2003; Villaseñor, 2003; Pineda & Halffter, 2004; Munguía, 2004 (with an extensive bibliography).

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