Biodiversity

Introduction

Biodiversity is the result of 3 billion 800 million years of evolution, and it is essential for the survival of mankind. In fact we depend on nature for many fundamental resources, among which food, building materials, heating, textile fibres and the active ingredients of medicinal products. Furthermore nature provides for other vital functions such as the pollination of plants, purification of the air, water and soil, etc. Today human activities are a severe threat for biodiversity, and they jeopardize the existence of numerous species. The destruction and fragmentation of the habitats, air, water and soil pollution, excessive fishing, the overexploitation of resources, forests and fields, the introduction of alien species and the emission of increasing amounts of gas with the greenhouse effect. That provoke climate changes, are only some of the causes of the loss of biodiversity.

Biological diversity

What is biodiversity?

The Earth is populated by an incredible number of different living creatures. The term that is used to define this “crowd” of organisms that populate every corner of the Planet, and that have adapted even to the most extreme environments, is biodiversity or biological diversity. Biodiversity measures the variety of animal and vegetable species in the biosphere and is the result of long evolutive processes.
The elements that make up biodiversity can be subdivided into three different levels:

- **Genetic level**
- **Species level**
- **Ecosystem level**

Genetic biodiversity

Genetic diversity refers to the differences in the genetic heritage of a species. The morphological characteristics, i.e. the visible characteristics of living organisms, such as for example the colour of the eyes and fur of a cat, which are examples of variety, from a genes level, in each single species.

Species biodiversity

However when we speak of biodiversity, we generally refer to the species biodiversity, i.e. the diversity of the different species in a determined environment, where by species we mean a group of organisms that can be crossed with one another giving life to prolific offspring. Species biodiversity can be measured through the number of species in a particular area (richness of species), the number of units in each species in a place (abundance of a species) and through the evolutive relationship of the different species (taxonomic diversity). For example, a man and a chimpanzee have 98% of common genes, but as we all well know, their characteristics make them very discernible one from the other. Some areas of the Planet have greater richness of species than others: at the equator, for example there is the largest number of species, that decreases nearer to the Poles. In the ocean there are many more different species near the coastlines than in the abysses.

Ecosystem biodiversity

The variety of environments in a determined natural area is the expression of biodiversity in the ecosystem, in other words, consider the differences there are, for example, between a temperate forest in South America and a mangrove forest at the Equator.

Why do we need biodiversity?

Each and every species has a particular function in an ecosystem. Some species can capture energy in various forms: for example they can produce organic material, contribute to the nutritive system of the ecosystem, control soil erosion, act as a protection from pollution of the atmosphere and regulate the climate. Ecosystems contribute to improving the production of resources, as for example, soil fertility, pollination of plants and decomposition of vegetables and animals. They also carry out real services such as: purifying the air and water, moderating the climate and controlling the rain or drought, and other environmental disasters. Obviously all these important functions are fundamental for human survival. The more varied the ecosystem is, i.e. the greater the biodiversity, the greater its resistance to environmental stress will be. The loss of even only one species often can provoke a decrease in the capacity of the system to remain preserved in case of degradation.
Biodiversity is like a large tank, from which humans can draw food, pharmaceutical products and even cosmetics. This helps to better understand the importance of maintaining biodiversity, especially in the case of agrobiodiversity, i.e. diversity in agricultural productions. This regards the innumerable quantity of plants that help to feed and heal human beings. It can be found in the immense variety of cultures and animal species with specific nutritional characteristics, in animal breeds that have adapted to hostile environments, in insects that guarantee pollination and microorganisms that regenerate the soil used in agriculture.
Biodiversity is an “assurance ” for life on our Planet, and therefore must be protected at all costs, because it is a universal heritage that can offer immediate advantages to human beings.
The economic importance of biodiversity for humans can be summarized as follows:

- Biodiversity offers food: harvests, silviculture, livestock and fish
- Biodiversity is fundamentally important in medicine. A very large number of species of plants is used for medicinal purposes since very ancient times. An example is quinine, extracted from the cinchona tree (Cinchona calisaya and C. officinalis) that is used to fight malaria. Furthermore some scholars believe that 70% of anticancer drugs are derived from tropical forest plants. It seems that out of 250,000 species of known plants, only 5,000 have been studied for their possible medical applications.
- Biodiversity has a remarkable role also in the textile fibres manufacturing industry, wood for building and for the production of energy. Many industrial products are obtained thanks to biodiversity: lubricants, perfumes, paper, waxes and rubber, are all obtained from plants; and there are also products of animal origin such as wool, silk, leather, hides, etc.
- Biodiversity is a source of richness also in the sector of tourism and recreational activities: wild natural environments and the presence of animals in fact attract thousands of tourists from all over the world every year.

Loss of biodiversity

Causes of the loss of biodiversity

The main cause of the loss of biodiversity can be attributed to the influence of human beings on the world’s ecosystem, In fact human beings have deeply altered the environment, and have modified the territory, exploiting the species directly, for example by fishing and hunting, changing the biogeochemical cycles and transferring species from one area to another of the Planet.
The threats to biodiversity can be summarized in the following main points:

1. **Alteration and loss of the habitats**: the transformation of the natural areas determines not only the loss of the vegetable species, but also a decrease in the animal species associated to them. Refer to “Alteration and loss of the habitats”.

2. **Introduction of exotic species and genetically modified organisms**; species originating from a particular area, introduced into new natural environments can lead to different forms of imbalance in the ecological equilibrium. Refer to, “Introduction of exotic species and genetically modified organisms”.
3. **Pollution**: human activity influences the natural environment producing negative, direct or indirect, effects that alter the flow of energy, the chemical and physical constitution of the environment and abundance of the species;
4. **Climate change**: for example, heating of the Earth’s surface affects biodiversity because it endangers all the species that adapted to the cold due to the latitude (the Polar species) or the altitude (mountain species).
5. **Overexploitation of resources**: when the activities connected with capturing and harvesting (hunting, fishing, farming) a renewable natural resource in a particular area is excessively intense, the resource itself may become exhausted, as for example, is the case of sardines, herrings, cod, tuna and many other species that man captures without leaving enough time for the organisms to reproduce.

Changes in and loss of habitats

One of the greatest threats for the survival of the species are the changes, loss and fragmentation of their habitat. Human beings, in fact, have deeply modified the territory, as a result of a large growth in the population, industrial development, the expansion of transportation networks, and agriculture and fishing on an industrial scale. An example of the consequences of the changes in the habitats can be seen In the Mediterranean Sea. *Posidonia oceanica* is an endemic marine plant in the Mediterranean that forms submerged sea grass meadows on the sandy bottom, which are a fundamental component of the equilibrium and of the richness of the sea coast environment. This plant has a great environmental value, in fact, one square metre of sea grass meadow can produce 10 to 15 litres of oxygen per day. Furthermore the meadows give shelter to a great variability of biological species, both vegetable and animal, (400 vegetable species and approximately 1000 animal species), in fact many animals find food and shelter there. Another important function carried out by Posidonia is to protect the sea coast, where it guarantees stability, acting as a protection from sea currents and the waves. It has been calculated that a regression of only one metre of the sea grass meadows can lead to a loss of about 15-18 metres of sandy coastline. Among the principal causes of danger for the Posidonia sea grass meadows is the fishing activity with bottom trawling nets that tear away the plants leaving the subsoil uncovered; and subsequent recolonization of these plants becomes difficult. If the meadows disappear, the principal effects will be: a loss of biodiversity, a change in the trophic network, a decrease in productivity with consequent damage to fishing itself, a change in the metabolizing process of trophic chains, an increase in coastal erosion, and the consequent decrease in the quality of the environment.

During the last century, changes in the territory consisted mainly of an increase in the surface area taken by agriculture and livestock farming, an increase in the urban areas, the development of road networks and the related infrastructures, the construction of hydroelectric plants and hydraulic plants, exploitation of underground deposits and fishing with more powerful boats and more efficient nets. Due to these changes, the natural environments are changed, destroyed and subdivided, which cause the loss, and division into small parts, of the habitats. The importance of the loss of the habitats is surely intuitive, while the concept of “fragmentation” is more difficult to understand. Fragmentation of the habitat is a division of the territory into various smaller areas that can remain, in some way connected to each other or may be totally isolated. The consequence of this leads to the subdivision of populations distributed in that particular area which are, therefore, less consistent than the original population. For this reason populations become more vulnerable to external stress, to climatic changes, to anthropic disturbance, epidemics and genetic deterioration due to cross- breeding among the population that is “related”.

For example, it is calculated that every year approximately one million specimens of amphibians in the region of Lombardy, are affected by car traffic. In particular, the species that are most affected by this problem are the green frogs (*Rana kl. esculenta*) and the common toads (*Bufo bufo*). When these animals move toward the reproduction areas, they are forced to cross a number of asphalted roads that are often found around the waterways in Lombardy. Therefore the

adult breeder specimens face mass extermination due to their slow and clumsy movement at dusk or during the night hours, before they have laid their eggs. It has been shown that the impact of roads can cause the extinction of these populations of amphibians.

Introduction of exotic species and genetically modified organisms (GMO)

Often a very important factor is neglected, which is the introduction of allochthonous species, i.e. species whose origin is in other geographic areas and that therefore have not adapted, through the long natural selection processes, to the new environment in which they are introduced.
It has been calculated that approximately 20% of the cases of extinction of birds and mammals is due to the direct action of animals introduced by man. The reason for this extinction can be attributed to various causes: to competition for limited resources, to predation by the "new" species, to the diffusion of new diseases and to the damages that the species that have been introduced can cause to the natural vegetation, to the cultivations and to zootechnics. An example of the problem in Europe is seen in the introduction of the grey squirrel (*Sciurus carolinensis*) imported from North America, that is replacing the red European squirrels (*Sciurus vulgaris*). Also the red eared slider (*Trachemis scripta elegans*) was imported into Italy from the United States as a pet animal, but when people started to free them in the ponds (because they became too big) this triggered a competitive mechanism between the American slider and the European pond turtle (*Emys orbicularis*).
Another problem that causes the loss of biodiversity is to be attributed to the introduction in the environment of genetically modified organisms (GMO) that are also known as transgenic organisms. A GMO is an organism, in whose chromosomes a foreign gene, taken from an organism of a different species, is inserted with genetic engineering techniques. In this way it is possible to create a new organism with particular desired characteristics: for example some organisms of the vegetable kingdom may become more resistant to herbicides or harmful insects; some livestock animals become more productive or more resistant to infections. With regard to the potential harmfulness of the GMO there is a violent debate between those who believe that the advantages for medicine and for society are greater than the possible effects on the environment, and those who state that too little is known to be able to use them, and that the environment will feel the effect of the genetic pollution of the natural species with numerous consequences: the involuntary transmission of resistance to herbicides in infesting plants, the evolution of more resistant parasites, the increased use of herbicides, the disappearance of species of insects and as a consequence the loss of biodiversity. Examples of GMO are to be found in two particular plants: maize and soya. In maize, resistance to harmful insects is obtained by introducing the Bt gene of the *Bacillus thuringiensis* bacterium. This bacterium, that lives in the soil, produces a protein that becomes toxic only in the insect's intestine, and causes its death. The protein is not toxic for humans nor for other animals, in fact, before the invention of these sophisticated techniques in genetic engineering, it was used as a natural insecticide, particularly in Canada to protect the forests from insect attacks. This technology, for the maize plants, leads to a decrease in the harmful insects and contamination by bacteria, virus and fungi, that can produce mycotoxins that are carcinogenic. The above technique is applied to soya in order to make it more resistant to herbicides; in particular to glyphosate and glyphosinate, that are biodegradable herbicides that are harmless for man and animals, but can kill all the plants. In this way it is possible to eradicate all the infesting plants without the need for further treatments with products that are extremely harmful for man and the environment.

Biodiversity and adaptation

Adapting in order to survive

Ecologists believe that every animal has its own "profession", which consists in finding the perfect correspondence among the species and its own ecological segment (i.e. the position of each species in an ecosystem). It would be absurd to think of finding an organism that has not "adapted" to its own ecological segment, in fact the penalty for this would be its rapid extinction.

By adaptation, we mean any structure, any physiological or behavioural process, that makes an individual, an animal or a vegetable more adapted to survive and reproduce itself than other individuals of the same species. By adaptation we also mean the evolutive process with which a new character is consolidated through natural selection. Adaptation can increase the efficiency in finding or using some fundamental resources such as light, air, food, etc.; or it can allow the organism to support determined conditions such as high or low temperatures, the absence of light or to help its defensive capacity.

The shark: a perfect machine

Incredible examples of adaptation can be found, in particular, among the sea organisms, that must live in a context such as water. You surely must have looked underwater with a mask, and surely you must have noticed how difficult it is to see far away. In fact visibility in the sea depends on a number of factors such as: the temperature of the water, the sea bottom, the plankton organisms and the suspension of various elements. Now imagine you live in this strange ecosystem and you are a large predator that must find food. In the depths of the sea very little light penetrates and often the suspension of a number of organisms makes it difficult to see clearly, but you are a famished shark that is looking for a succulent prey. Everything is very dark, yet you notice that the prey you want is there, and with a rapid stroke you capture it between your teeth! Good eyes surely are not enough to be an efficient predator and therefore nature has had to “invent” really particular adapting strategies in order to survive. In fact sharks have two senses more than us humans: the **lateral line sensory organ** and the **Ampullae of Lorenzini**.

The lateral line sensory organ consists of a series of small channels along the shark’s sides, under the skin surface, that contain tiny sensory hair like structures that are sensitive to the water movements around the body provoked by waves, prey or predators. Therefore this organ allows the sharks to identify objects that are moving (even without seeing them!) and to pinpoint their position remarkably precisely. In fact, every moving body in the water produces vibrations that are transmitted in the environment, spreading out like concentric rings that form on the surface of a lake after a stone has been thrown into it. These vibrations differ, depending on the size of the animal and its state of health. And this is the reason why sharks almost magically appear in a few seconds when a fish is captured or wounded!

However, the sharks’ adaptation to life underwater does not finish here, in fact they have another important sensory organ, the Ampullae of Lorenzini. This organ consists of small pores in the area of the shark’s head, with ampoules that are filled with a conductor gel, connected with nerve fibres. The sensory cells can distinguish very weak electrical fields generated by other animals at a close distance (20-30 cm, maximum a few metres). In fact all living organisms have an electric potential (in fact, electrocardiograms and encephalograms are based on this phenomenon). So thanks to this very particular organ sharks become like metal detectors, and can locate magnetic fields generated by their prey, that may be perfectly hidden or mimetically invisible, but will certainly not be able to inhibit the electricity of their body. For this reason not even a sole, that remains perfectly hidden under the sand is safe! The Ampoules of Lorenzini are an organ that is so sensitive that it can capture magnetic fields ranging from 0.01 to 0.0005 microvolt per centimetre, which means that a battery that we consider completely dead, could be an enormous source of energy for a shark.

Sea mammals : perfect apnoea swimmers

For how long can you hold your breath? If you are good you may even hold it for a minute or two. However some sea animals can reach an hour or more. This is the case of cetaceans that are mammals, and breathe with their lungs, and therefore must reach the surface in order to breathe exactly like us humans. However particular mechanisms help them to prolong the time of apnoea (i.e. their capacity to hold their breath), specially in species such as the sperm whale, that feed on giant squid, which can be found at great depths. In fact the sperm whales can reach depths below 2000 metres (a scuba diver with an oxygen supply generally does not exceed a depth of 40 metres when diving for fun) with apnoea lasting up to two hours. They have a high haemoglobin density (the protein that is present in the red blood cells that enables the transportation of oxygen), in the blood and myoglobin (a protein that is present in the muscles that can store oxygen) in the muscles : a high dose of these proteins therefore, means a great amount more of oxygen that is stored and therefore their capacity to hold their breath will be longer. These sea mammals are also able to slow down their

heartbeat and to cut away less important organs from the blood stream, so as to supply oxygen where it is most needed, for example in the brain.

Everyone at the barber's shop: cleaning stations

To live in the water does not necessarily mean being clean! Fortunately there are sea organisms that, during the course of evolution, were transformed into real "cleaners" of other fish. These animals live in a place known as the cleaning station, where other fish stop by in order to be completely cleaned from external parasites and remains of food, as if they were at the barber's. There is a symbiosis in these areas, because the cleaners and the barbers both draw advantage from this : there is relief for the "clients" which also avoid getting any sickness, and food for the "barber". In these particular areas the cleaner fish have learnt to perform a dance that distinguishes them from other fish, and also their colouring is quite recognizable: when a client comes near, the cleaner fish begin to wiggle about using only their side fins, so as to show their intention to the client and to avoid becoming the prey of the bigger fish. And here also the cleaner shrimps can be found, which have the same function as the "barbers" and they too have a particular colouring and dance in order to be recognized. The fish that need cleaning, once they have recognized their barbers, remain perfectly still while they receive these services and they also open their mouths and gills in order to allow access into the more important areas. And in this way the leftovers of the last meal are removed and also the parasites that are encrusted in the gills and on the skin. Often the "barber shops" are places that are easy to recognize because of their particular appearance: a large solitary madrepore in the middle of the coral reef, a large flat coral. The clients memorize the place and return every time they need, without ever leaving a tip!

Biodiversity and camouflage

The camouflaging strategy

If a subject moves, the eye can see it helped by various elements that are correlated to the visual capacity of the subject following the action, even a shadow that passes rapidly leaves a sign on the retina, and so it is possible to find its origin. When instead there is no movement, the eye can only see a different shape on a coloured background. The hunting instinct is turned on, in fact, by determined "research images", i.e. shapes and colours that immediately stimulate the preying instinct, and whatever does not belong to these images, does not arouse much interest. And this makes you understand the importance of camouflage in the animal world, as a particular example of adaptation to the environment: the preys and the predators have in fact had to "invent" strategies to increase the possibilities of capturing their prey, or of escaping from the possible predators.

Distinguishing the cleaner by its clothing

In the cleaning stations which we mentioned here above, often there is also a strange fish that may be confused with the cleaner wrasse. Instead, this fish belongs to the Blenny family: it is of the same size as the cleaner fish, it has the same colouring, it also moves in an identical manner and even imitates the famous cleaner fish's dance perfectly, but unlike the cleaner fish, it has powerful teeth and in fact it is known as the sabre toothed blenny. All the fish that are already accustomed to the cleaner fish, show a friendly attitude with their cleaning request, also when they see this "perfect impostor", but they are in for a terrible surprise. In fact the imitator goes near to the fish that would like to be cleaned and with a powerful bite it cuts off a piece of the unfortunate fish's fin and swallows it. The wounded fish turns around immediately, but the fake cleaner, like a professional actor, remains absolutely still seeming perfectly innocent and with this "trick" it saves itself from the aggression.

Two heads are better than only one

The body surface of some fish may have varied colour combinations, often they are extremely colourful as in the tropical species that live in the coral reef. The scope of the colouring is to avoid being identified by the prey or by the predators. This aim is reached with camouflaging colours or instruments such as "false eyes" or eyespots that confuse the predators. In particular the eyespots are dark spots that vaguely look like eyes, like those in the butterflyfish, which are

there to confuse the predators and are generally to be found in the area of the tail. And so the predators attack the tail that they think is the head, thus wounding the animal in the less delicate part of its body, which enables the fish to escape in the meantime.

The champion of camouflages

In some cases the animal may even imitate the shape of the inanimate elements that are present in the environment it lives in, and also the colour of the subsoil. The champion of camouflage is surely the polyp, a Cephalopod mollusc (not to be mistaken with the coral polyp). Polyps have very evolved camouflaging systems that are very sophisticated. In fact it can change the tones and the intensity of its colours thanks to particular star shaped cells called chromatophores. These cells contract and dilate the pigments that are within depending on the stimuli that the animal receives, and in this way they are able to regulate the chromatic intensity of the skin. This invertebrate creature can even merge into the rocks nearby, perfectly imitating the sharp edges of the area all around. Once it is camouflaged it can easily capture the prey it eats, undisturbed.

Eat me and you will regret doing so !

The characteristic that distinguishes the nudibranchs, small sea slugs without a shell, is surely the variety of colours and patterns of their skin, a variety that has no rivals in the animal world. Up to some years ago, it was believed that those colours could help the nudibranchs to recognize members of their own species, subsequently instead, it was discovered that these molluscs are not even able to distinguish shapes, let alone colours. It is even more complicated to understand what could be the meaning of those flashy colours, considering that a similar covering makes the small and undefended animal stand out even better, and therefore it can increase the possibility of it being intercepted and captured by a predator. The bright colours in this case are a symptom of danger: the predator that eats a nudibranch is in fact, struck by the urticating cells that the mollusc is able to accumulate in the extroflexions of the intestine, derived from the coral polyps that this species eats. Once it spits out the urticating prey, the predator will remember, for the rest of its life, that those colours lead to a really inedible morsel.

Extinction is for good

What is extinction?

Extinction is an evolutive process that leads to the disappearance of a species or a population. When a species becomes extinct, its entire genetic heritage is lost for good. With evolution, a species can become another in order to adapt to the small environmental changes or due to casual changes in its genetic heritage. This process is known as speciation, in other words the birth of a new species. Speciation and extinction are both part of the natural evolutive process of living beings. Therefore, the natural extinction of a species in itself must not be interpreted as a negative event (nor, obviously, as a positive event), but it must be considered simply for what it is, in other words, an expression of biological evolution. The great extinctions in history, in fact, were accompanied by the formation of new species that have given continuity and vigour to the diversities of life.

Normally two types of extinction may be classified. There is the background extinction that is the slow and, for us, imperceptible trend of the living creatures to transform constantly. And then there is the episodic extinction, with massive and concomitant deaths of species, triggered by rapid changes in the environment.

In general, the extinctions that contributed most to the drastic changes in the flora and fauna in the earth's history, were of the second type. Some extreme events took place on a vast scale during the course of the geological eras, like climate changes or the impact of our planet with comets and asteroids, which translated into environmental perturbations that were so radical that there were not many possibilities of escape for a multitude of organisms. At various times of the Earth's history, these phenomena have been very severe limiting factors for the survival of the species, and at times these have drastically cut biodiversity in entire geographic regions, causing the so-called mass extinctions. Palaeontology experts have discovered five great mass extinctions in the last 500 million years. From the famous one

that led to the extinction of all the dinosaurs on the Earth. During these great extinctions it is believed that 75 per cent to 95 per cent of the number of extinct species is believed to have gone lost.
However, today the extinction rate is not considered natural, but the main cause of it all appears to be mankind, that, according to some scientists will cause a sixth mass extinction. In fact approximately 23 per cent of the Mammals and 12 per cent of the Birds are considered to be endangered by IUCN (the International Union for Conservation of Nature).
There seem to be a number of causes that lead to this rapid mass extinction, however they are all caused by humans:

- constant growth of human population with a non-sustainable life-style
- increase in urban areas
- increase in the production of waste and polluting substances
- increase in alien, non autochthonous species
- climate changes
- international conflicts

The extinct marsupial wolf

The thylacine, also known as the Tasmanian wolf or Tasmanian tiger, was the largest known carnivorous marsupial. Thylacines were widespread all over Australia and New Guinea, but these were confined in historical times in Tasmania, where now they have become extinct. The thylacine looked like a dog with stripes, but could sit on its hind legs and on its tail like a kangaroo and jump forward 2-3 metres with great agility. At the time of European colonization, the thylacine lived in Tasmania and was widespread specially in the areas near the forests. Probably it hunted at night in the grasslands while during the day it rested, hidden in the forests. The extinction of this curious animal seems to be due to different causes among which the consequence of competition that arose with the dingo, but not only this. Since the times of European colonization the marsupial wolf got the unhappy reputation of being a “predator of sheep”. From 1830, rewards were promised to those who killed this animal, up to 1850. In 1888 the Government of Tasmania again began offering rewards to wipe them out, and in only a few years 2268 were killed. This criterion fell into disuse in time, and in the end it was thought that an epidemic had definitively made the thylacines extinct. The last thylacine was captured in 1933 in West Tasmania and died in the zoo in Hobart in 1936. Since then many researches have been made to find traces of survival of the thylacine, with no results. No one will see a live thylacine again!

The roots of the problem

In purely ecological terms, what provokes the extinction of a species is the destruction of its habitat and the impossibility to find another one. When the environments change, many of the physical and chemical characteristics change with excessive speed compared to the time for biological adaptation: the organisms that live there die, unless they are able to migrate. The five great biological extinctions of the past were provoked by ecological dynamics that did not depend on human impact (also because the appearance of Homo sapiens was remarkably later) that had these characteristics. For example, biologists believe that the two extinctions of the late Ordovocian era and the late Devonian era were the result of a violent change in the conditions of the climate; while the interpretation of the extinction of the late Cretaceous era was due to the effect of the collision of our planet with one or perhaps two large meteorites. It is known that these collisions had such repercussions on the global biological balance, that they led to the disappearance of the dinosaurs and many other organisms. At present, however, the planet is experiencing a condition that had never occurred in the past, at least in the amount that we can see today: the rapid disappearance of species due in particular to human beings. Scientists believe that the speed of erosion of biodiversity today is similar to what characterized the great extinction events of the past, with the sole difference that this time the cause is to be found in the anthropic activities. Diversely

from what has been stated about the five historical extinctions, then in this case we must deal with a process that, besides having obvious ecological implications, it also has an ethical and cultural value that must not be neglected. In fact we wonder if it is right that man should dilapidate the biological richness of the planet, without thinking of his responsibilities with regard to the survival of nature and of the future generations of human beings. Many authors believe that the “ecology crisis” that we are going through may have negative consequences on the quality of our life in a very short time, and it is obvious that this worry leads to reflections and discussions that are not only scientific.

Humans and other species

There are different ways in which humans have become responsible for the disappearance of other species. From this point of view a fundamental responsibility is the impact of agriculture on the world ecology. The conversion to agriculture of the land, that has taken away considerable areas from the forests, the grasslands and the humid environments, has deeply simplified the ancient structure of biomes and ecosystems. Naturally these alterations have had differential results in terms of extinctions in the tropical and subtropical areas where biodiversity reaches its peak, the results of the agricultural conversion of the territory have been much greater than in the higher latitudes. But also industrialization and urbanization have played a key role in the extinction of the species. In particular, in the last three-four centuries, the human population has registered a rate of growth that had never been noted in the past, and anthropization of the natural environments that derived from this and all its consequences in terms of cementing, industrialization and deterioration of the territory, has deeply modified the features, and the ecological quality of the habitats. Another crucial factor in the present loss of biodiversity is to be found in the anthropogenic climate change. The accumulation of greenhouse gas emissions produced by human beings in the atmosphere in fact has produced an increase in the global temperature, that in many regions of the planet is already pointing out severe biological alterations and documented extinction phenomena. The origin of the extinctions that are being recorded all over the world however, is not very recent. Due (directly or indirectly) to man, many hundreds of animal and vegetable species have become extinct starting 400 years ago. Furthermore it must be taken into consideration that many other species today can survive only because they are bred in captivity or are under the protection of conservation programmes. The IUCN (International Union for Conservation of Nature and Natural Resources) organization cyclically issues a “red list” of the organisms that are threatened by extinction. At present the list includes 12,500 species subdivided into the categories “in critical danger”, “in danger” and “vulnerable”. For example, out of the almost 10,000 species of birds, over 1,000 are classified in one of the three categories indicated above. Which means that more than 10% of the avifauna in the world, has a significant risk of extinction. However the problem may be even more severe. In fact if on one hand many “vulnerable” organisms can be monitored quite easily nowadays, and therefore effective measures can be carried out in order to protect them, on the other hand there is an entire universe of organisms that cannot be controlled easily that, due to their microscopic size, their habits or for the simple fact that they still have not been discovered, escape any form of assessment of their state of conservation. A precise definition is important because most of the biomass of the planet is probably concentrated in these organisms, which in turn play an indispensible role in the balance of the ecosystems.

Human weight on nature

In order to visualize the weight that our species has on the global ecosystem, consider that the entire area of the Earth, is about 51 billion hectares. The surface area above sea level, accounts for little more than 14 billion hectares, which, according to the calculations made by FAO (Food and Agriculture Organization), are in turn subdivided as follows:

- 2 billion hectares of cultivated and built-up areas ;
- 3,4 billion hectares of permanent meadows and grasslands ;
- 3,8 billion hectares of forests and wooded land;
- 5 billion hectares of frozen land, tundra, deserts and humid environments.

Therefore it is evident that for the production of food, in order to exploit and extract the resources, and in order to dispose of human waste, it is necessary to make use of the surface that is still available. This is a compulsory step, because the surface of the planet is suited, and its productive capacity is great, but it is not infinite. It has been calculated that humanity, at the present population pressure has about 2.3 hectares of bioproductive territory per head (the average amount of earth that is available to obtain food), and the calculation includes the fraction of dry land for agriculture and breeding livestock, and also the fraction of ocean surface that is necessary for fishing. It has been noted however that the estimated 2.3 hectares only bear in mind the requirements of our species, neglecting the needs of all the others. Taking into consideration also these requirements, and taking the projections of the United Nations, according to which in 2050 the human population will reach a total of nine to ten billion people, to be correct, it has been noted that the bioproductive territory per head is destined to fall below one hectare. The question at this point is: will this surface per head be sufficient to guarantee the survival of mankind without further jeopardizing biodiversity of the planet?

From extinction to conservation

The risk of jeopardizing the biodiversity of the Earth at this stage is quite evident, and it is equally evident that the answer cannot be found only on a scientific scale, but must also be discussed on a cultural scale. In fact if we think of the role of the biological heritage for the survival of human beings, it is possible to see how important the action of biological conservation that now involves the institutions and agencies all over the world is. The most important step made up to date to formally confirm the need to save the natural heritage, is the international treaty known as the Convention on Biodiversity (CBD). The agreement was signed in 1992 by 156 countries (including the European Union), during the course of a Conference on Environment and Development organized in Rio de Janeiro by the UNO (United Nations Organization) and it established the principle that biodiversity is a heritage that belongs to the entire humanity, and as such must be used according to ecological sustainability criteria and social equity among all the populations worldwide. The concept of conservation as a topic that is worthy of international attention, is however older than the CBD. In the last century, the first efforts to understand this problem thoroughly and to manage it rationally, led to the foundation of very prestigious organizations such as the WWF (World Wildlife Fund) (World Wide Fund for Nature) and others. In these organizations, highly qualified experts on the environmental, social and economic topics are employed. Therefore conservation has become much more than an exclusively scientific matter, it has become a matter that needs to be solved with adequate measures that range from economy to law, from social science to natural science, from philosophy to biomedicine and so on. Experts have noticed that extinction and all the other forms of erosion of biodiversity can be faced only with the instruments made available by different fields of knowledge. As a matter of fact, what seems increasingly necessary is a different way of dealing with the relation between man and nature: a challenge that cannot be faced with only one form of knowledge.

The value of biodiversity

Man and biodiversity

Due to the growth in the human population, in production and consumption, over the last two centuries the natural ecosystems of our planet have been subjected to an impressive depletion of their biodiversity, with an overall decrease, measured by the Living Planet Index, equal to 30% from 1970 to 2005. Human activities have increased the rate of natural extinction and it is estimated that the current climate change will worsen the situation further. Biodiversity is important as a value itself, also because it contributes to human wellbeing: the vegetable components and the fauna in the forests are an important source of food for many local populations, they are a source of active ingredients (25% of the drugs), they contribute to increasing the revenue and freedom of choice of the local populations, they are remarkably important in social relations and conservation of the cultural heritage.

Definition of ecosystem services

According to the definition of the Millennium Ecosystem Assessment (MA, 2005), the ecosystem services are the

benefits people obtain from ecosystems. The Millennium Ecosystem Assessment describes four categories of ecosystem services:

- Life supporting services (such as the nutrient cycle, chlorophyll photosynthesis, soil formation and primary production);
- Provisioning services (such as the production of food, drinking water, materials such as wood and combustibles);
- Regulating services (such as climate regulation and regulation of the tides, hydrogeological order , purification of water, waste recycling, pollination and barrier for the diffusion of diseases);
- Cultural values (among which aesthetical, spiritual, educational and recreational values).

Ecosystem services

Let us now look at the principal services provided by the ecosystems, in detail.
Regulation of the atmosphere: the ecosystems regulate the chemical composition of the atmosphere thanks to gas exchange of oxygen and carbon dioxide. For example, each tree produces an average of 20-30 litres of oxygen a day. A virgin tropical forest produces 28 t . of oxygen per hectare per year, equal to a total of 15.300 million tons per year.
Regulation of the climate: biodiversity also regulates the conditions that determine the climate, such as the temperature, the winds, precipitation, the formation of clouds etc. In particular, for example, the forests help to subtract carbon dioxide from the atmosphere and transform it, through photosynthesis, into carbon, that is then “stored” in the form of wood and vegetation. About 20% of the weight of trees is made up of carbon, and the entire forest biomass acts as a ”carbon absorption tank”: destruction of the forests is one of the main causes of the carbon emissions in the atmosphere.
Protection from catastrophic events : vegetation contributes in keeping from catastrophic events such as tornadoes, floods, landslides, hydrogeological disorder etc.
Regulation of the water cycle: the ecosystems control the hydrogeological flows. The water cycle that passes through all the ecosystems allows its use through evaporation, condensation, precipitation, infiltrations and water flowing on the surface and underground. The structure of the plant roots of a forest keep the soil compact, and the decomposing organic vegetable material combines with the minerals, forming a sort of gigantic sponge that, following a slow and regular rhythm, releases the water in the surrounding areas. In one day, a large jungle tree can free approximately 760 litres of water into the atmosphere as vapour, in particular half a hectare of primary jungle frees approximately 75,000 litres, 20 times more than an analogous surface of the sea.
Water supply : the rivers, the lakes and the underground water table act as tanks of fresh water, that is indispensible for life.
Erosion control: vegetation prevents the loss of soil due to the rain and the wind, allowing soil stability. Accelerated erosion processes can lead to hydrogeological disorder and instability on the hillsides.
Soil formation: the exchange between the organic substratum, the climate and some organisms such as earthworms, mosses, lichens and bacteria, together with physical, chemical and biological processes, lead to soil formation.
Nutrient cycle: this is the set of natural processes that make all the substances that are indispensible for life, such as oxygen, carbon, nitrogen and water available again.
Waste recycling : the ecosystems can absorb waste substances and purify the environment. When man-made substances and materials that are not biodegradable are introduced into nature, or if these are persistent, this capacity fails.
Pollination: wind, water and many animal organisms allow the fertilization of the plants, and consequently, the production of food and vegetable materials that are useful for humans.
Regulation of the biological balances: all living beings have a close relation with one another, as for example the

prey/predator that conditions life on the Earth.
Shelter: many habitats are a place of refuge and protection for many species, especially during the period of reproduction, and this can influence other services such as “regulation of the biological balances” and food production.
Production of food : the food pyramid is a clear example of food production. Every species can become food for another. Starting from the plants that, thanks to photosynthesis, are able to produce nutrient substance for all the other species.
Production of raw materials: the living species are an irreplaceable resource for human beings, of materials such as wood, fibres and combustible fossils.
Biological variability : biodiversity is based on the enormous number of existing species and their genetic variability. This allows human beings to avail of natural substances, active ingredients, domestic breeds and cultivar.
Recreational : humans exploit the ecosystems as locations for their recreational activities, for tourism and sports. This function therefore is fundamental for the psycho-physical balance of human beings.
Cultural: biodiversity is a stimulation in the scientific, artistic, spiritual and emotional fields.

Let’s save biodiversity

What you can do

With small daily actions also we can do something important to preserve biodiversity. Here is some advice:

- Don’t buy animals and rare plants or objects produced with tortoise shells, ivory, exotic feathers, shark teeth, fur,
- coral and shells: often their indiscriminate catching threatens the entire ecosystem where they live.
- Avoid killing organisms with no reason: sport fishing isn’t better than hunting!
- Don’t deteriorate the environment: a wood full of rubbish kills many more human beings than you can imagine.
- Try to avoid all any energy waste: don’t forget that using energy means producing carbon dioxide that has an
- impact on climate change and therefore on the survival of many organisms.
- Move preferably on foot, by bike and public transport: in this way you will contribute to a cleaner air and will have
- the oppurtunity and time to observe better the living beings that live close to you.
- When it’s possible favour recycled products: don’t forget that trees are cut down to produce paper!
- Don’t feed wild animals as you could alter the delicate balance of the food chain and involuntarily cause their death.
- Surely it’s exciting looking at a fish as it’s eating bread gut from your hands but these animals will never find this
- type of food in nature as it swells them and often causes mortal diseases.
- Always remember that in every natural environment where you might be, from forest to sea, we are always guests
- and as such we should respect all life forms, including those which seem most insignificant: for this reason, don’t
- collect flowers that are surely nicer in a meadow than in a vase in your house waiting to die!

- Plan your day on biodiversity: in this way you will have the chance to admire different species and learn to recognize them.
- Try to communicate to everyone close to you respect and love for nature but also everything you have learnt on this issue: we love more easily what we know and it's easier to protect what we love!

Biodiversity day

Decide the place where you can spend your observation day: often it's not necessary to cover hundreds of kilometres to find an environment full of life, sometimes, we can unexpectedly make beautiful observations close to home or even in the garden of our own house.

- Dress suitably to the place where you are and comfortably: shoes are very important to walk well, but also pay attention to the colour of your clothes. Many mammals, infact, can't see red and purple but birds can. A bright-coloured shirt is the best way to avoid seeing animals!
- Bring in your backpack everything you need for your observations: a map of the place, pocket guides to recognize animal and plant species, a compass to guide you, binoculars to look far away, a magnifying glass to observe details, a camera to capture your encounters, a notebook where you can carefully mark your observations, pencils to make sketches of the site and species living in it.
- Keep silent as much as you can: all animals have great sense of hearing, making noise you risk provoking a general stampede.
- Walk slowly: rapid and sudden movements alarm all animals and reduce the chance you might have to make thrilling encounters.
- Keep your eyes open and ears peeled: listen to the sounds made by animals, you will understand where they are and be careful about their movements, infact, our eyes are attracted by movements and so it will be easier to see a moving bird rather than a still one.
- Look in all directions and use binoculars only after being sure there is something: if you keep using binoculars you risk losing "closer" encounters.
- Fill in your notebook in this way: date, beginning time and end of your field trip, place and climate conditions and a quick sketch of the place where you are; if you know it, write the name of dominant plant species in this place and plant and animal species observed or draw a quick sketch or add a picture for further identification.