SCIENCE AND THE FUTURE OF THE BIOSPHERE

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Ladies and gentlemen, I will begin with some thoughts about changes in the biospere including the human race. I will also deal with the role that science can play in the solution of the problems connected with these changes.

When I speak about the future I do not mean tomorrow or the day after tomorrow. As a Biologist dealing whith Human Ecology I try to have a look at the biosphere with a longterm perspective.

The earliest traces of life on earth date back about 4 billion years. Astrophysicists assume that the sun which is a fundamental condition of life on earth will deliver the necessary energy for another several billion years. So the biological evolution has approximately reached its half-time.

A relatively young product of the biological evolution is the human race which developed culture and began to dominate other forms of life only a few thousand years ago. This naked ape, as it was called by Desmond Morris, labelled his own species Homo sapiens, the wise being. The technological progress of the past few centuries seemed to support this designation, but at present we can easily recognize it as a euphemism. The Austrian ethologist and Nobel prize winner Konrad Lorenz put it like this: „The long-searched-for missing link between the ape and the truly human being – that is us!"

An important question arises: How long will the future of Homo sapiens be? Hundreds, thousands or millions of generations ? We don´t know. But we do know that the present generation determines the conditions for life on earth as no generation did before. Ecology can be called the science of small causes and big consequences. Many things we are doing have consequences which extend far into the future. For example, if we release radioactivity into the environment, there will be mutations in living cells with the consequence of a genetic load which produces an increasing number of inherited health effects in future generations. Or look at species depletion. Every extinct species is an irreversible loss. On the other hand, every successful measure pertaining to nature-conservation or environmental hygiene has far reaching positive consequences.

THE CONCEPT OF SUSTAINABLE DEVELOPMENT

Only recently has the future aspect of the environment been taken into account by official bodies. In 1987 the United Nations world commission on environment and development defined „sustainable development" as: **„development that meets the needs of the present without compromising the abilitiy of future generations to meet their own needs"**

As indicated before, future generations should not mean a few, but countless ones.

Sustainable development clearly is an ethical concept. One of the basic criteria for evaluating an act is, whether those who are affected by the consequences of the act could agree. Consequently,

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we should treat the ecosphere in a way that future generations would be able to give their consent.

Sustainable development is an **anthropocentric** concept because it takes into account only the wellbeing of humans.

Anthropocentric environmental ethics, however, is not able to attain its own objective. Inasmuch as only human needs are taken into consideration, nonhuman forms of life and ecosystems are only exempted from destruction if they are clearly useful to humans. Those judged to be useless will be traded off cheerfully for shortsighted interests. So the narrow-minded egotism of humankind will fail because in our vast ecological ignorance we do not know in which way the web of life supports the existence of humankind. The experiment Biosphere II showed clearly that it was not possible to compose a sustainable ecosystem with a few components. A wise man once said: „Planning replaces chance by error". So a farsighted anthropocentrism comes close to biocentrism, a position which respects the right to exist of every form of life.

So I think, that the only sustainable foundation for a future in dignity is a radical ethic of „Reverence to Life" such as Albert Schweitzer proposed and followed.

„If the world's air is clean for humans to breathe but supports no birds or butterflies, if the world's waters are pure for humans to drink but contain no fish or crustaceans or diatoms, have we solved our environmental problems?" asked David Quammen in his paper „A planet of weeds". As a matter of fact, currently we are on the best way to approach this situation. Because of the destruction of forests, water bodies and other natural habitats as a consequence of overpopulation and ever growing demands, we can observe an alarming decline in biodiversity comparable only to a few mass extinctions which took place in the past.

The so called Ordovician extinction, 439 million years ago, resulted in the disappearance of about 85 percent of marine animal species at a time before there were any animals on land. The worst extinction ever was the Permian extinction about 245 million years ago which eliminated about 95 percent of all known animal species. The most recent and most familiar was the Cretaceous extinction which at the boundary between the Cretaceous and the Tertiary ended not only the age of dinosaurs but also brought extinction of the marine reptiles and the ammonites, as well as major losses of fish species, mammals, amphibians, sea urchins, and other groups, totaling more than 70 percent of all species. The reasons for these breakdowns in biodiversity are not yet well understood.

In our present man-made decline in biodiversity, five causal factors account for most extinctions: habitat destruction, habitat fragmentation, overkill, invasive species, and secondary effects cascading through an ecosystem from other extinctions.

Cascading effect means that if for example a bird species is eradicated which disperses the seeds of a rainforest tree, this tree species will also be lost in the long run and so will many other species whose ecology is not yet understood.

Among the first well documented cases of fragmentation is the Borro colorado island. This island was isolated from a large rainforest area by flooding when the Panama canal was constructed. In the following decades the number of species there declined steadily. One branch of ecological theory is called island biogeography. It connects well studied island cases with the the mainland problem of forest fragmentation and it arrives at estimates which suggest that by the year 2040, between 17 and 35 percent of tropical forest species will be extinct or doomed to be.

If the present trends of deforestation continue, the result could be the loss of one or two thirds of all species. Can the creation of protected areas stop this process? The present worldwide total of

protected areas is about 6 percent of the planet's land area. Even in those parks and reserves it is not possible that their full biological diversity will be retained.

Human population growth will make a bad situation worse by putting ever more pressure on all available land. Human impact is a product of three variables: population size, consumption level, and technology. Even if there is a lot of progress in clean technologies, an undeniable reality will remain: more people will need more land.

Extinctions are not only caused by destruction and isolation of ecosystems but also by „dislocation“ of species. A well documented case is the introduction of goats to St. Helena island by Portugese sailors shortly after its discovery in 1500. At that time the island was covered by tropical forest. The goats began to multiply rapidly and prevented the rejuvenation of trees. Three hundred years later the forest with its high biodiversity was gone and so was most of the fertile topsoil. A rich ecosystem had been destroyed by only one introduced species. At present a breakdown of endemic fish species is taking place in Lake Victoria after the introduction of the Nile perch Lates niloticus in the sixties. There are countless similar cases which show that narrowminded human attempts to „improve“ nature lead to catastropic consequences by throwing ecosystems into disorder.

Dogs, cats, goats, pigs, rabbits and unintentionally also rats, mice and certain insects have become cosmopolitans together with man. Some of the dislocated species went wild and invasive and began to cause havoc in what for millions of years had been sheltered and less competitive ecosystems.

Dislocated species which are versatile, prolific, aggressive and ready to travel are termed weedy species. These features they have in common with the human species.

Many people argue that the ultimate question connected with the global ecological crisis is the survival of the human species. I don´t think Homo sapiens is an endangered species as far as its survival is considered. Our species is so dominant, prolific, generalistic and adaptive that perhaps it will be one of the weedy species which will survive the ongoing mass extinction. Some look at humans as the most successful weed of the planet earth. The question therefore is not survival or not – the question is about the conditions of survival.

There are not only the spiritual and aesthetic values which a rich biosphere offers to man, there are many other benefits of diverse balanced ecosystems, for example the cleaning and regeneration of air and water. Losses of these systems will make life for man more stressful and difficult, especially for the growing number of the poor. It is not the human species that is in danger, but the human values.

So, if we speak about sustainable development we should put the emphasis on stopping the process of ecosystem destruction. One motto must be: Reforestation instead of deforestation!

Given the need for more fertile land for a growing human population, the inevitable expansion must not be at the expense of natural ecosystems.

Reforestation of destroyed areas is not so easy as cutting down trees to create additional land for agriculture, but it is possible. In any case, it is worth the effort. Instead of directing huge financial and human resources into weapons and trained armies for mass-murder, it should be possible for a being calling itself Homo sapiens to reverse the process of destroying the biosphere.

THE ROLE OF SCIENCE

Until recently science and philosophy were a unity. Their objective was the search for knowledge, the search for the only truth which they expected to find.

Basic questions of Philosophy were:

Who am I?

What can I know? and

What am I to do?

The claim that the quest for knowledge and truth should not be hindered by ideologies or dogmas seems to be so justified and self evident that it automatically leads to the postulate of the freedom of science. But science is not only the quest for pure knowledge. Francis Bacon, who profoundly influenced modern thinking claimed that „Knowledge is power!“ He understood science as a means to get nature under control.

In the modern times since then, considerable progress has been made and many splendid achievements have been attained which seemed to be impossible before. (e.g. aviation, nuclear fission, microcomputers, or genetic engineering). Knowledge and technological capabilities reached truly unbelievable dimensions, but at the same time the dimensions of catastrophic failures on global scale also became manifest.

Why is this so?

Here we touch the second philosophical question I mentioned: What can I know?

Since Immanuel Kant we have known that a priori to every knowledge there are the categories of space, time and causality. Man is able to think in the categories of cause and effect in a simple, linear way but he is not able to understand complex systems. Science and engineering are masters only over small sections of reality and must fail when they apply their concepts to the complex biosphere.

The specialisation of modern science leads to the fragmentation of knowledge, and that fragmentation again leads to what can be called the „sin“ of modern science viz. the attempt to explain and improve the world from a reductionist position. Scientismus and technocracy reflect the current common attidude that science is the only way to knowledge and that there is a technological fix for the solution of every problem. „Technology is the answer – but what was the question“ Amory Lovins once said.

On the other hand, ecology, as the science of the complex interrelated systems of the biosphere has demonstrated that interference with the delicate web of life can be very effective. It can quickly destroy viable and proven diversity the evolution of which has taken a very long time.

The catastrophic failure of many an experts promise has discredited modern science. However it would be quite stupid to draw the conclusion, that because science is not sufficient for the solution of many problems science is unnecessary. Today we don´t need less but more rationality or rather a comprehensive rationality. For example it is not rational to believe that genetic engineering with its molecular biology approach which ignores the ecological implications will improve the world.

The only legitimate realism is the one of the laws of nature – nature can not be deceived.

Specialized knowledge must be complemented by systems knowledge.

Science and responsibility

Scientific responsibility today must be more than perfect methodological professionalism in a special field.

The potentially grave implications of modern technology mean that it is not sufficient to evaluate acts according to the motives behind them. It is not sufficient to justify innovations from only one aspect. This ethic of motives must be complemented by an ethic of responsibility (in the sense of Hans Jonas) also called the ethic of consequences. An action is justified only if according to the best knowledge available severe negative consequences can be excluded.

To participate in obtaining „the best knowledge“ and in helping to make it effective in society should be a prime task for the scientist. Science can not be separated from responsibility. Freedom of science should first of all be the freedom to act responsibly, the freedom to oppose the exploitation of science by corporate and political intersts.

Scientists must not play with new possibilities like naive children. If they close their eyes to potential irreversible consequences of their work they have to accept to being called ecologically and ethically infantile and retarded.

Science needs control from inside but also from society. This requires openness, and a scientific community which not only communicates with the public but also opens itself to borderline and value questions.

Normal science produces knowledge but not wisdom.

Critical science in the interest of life has to strive for wisdom that is the knowledge of how to use knowledge and so it has a close affinity to philosophy. Perhaps in the long run science can contribute to the justification of our species name of Homo sapiens.