DIGIT~Bio~TECH

LO8 BIOETHICS AND MODERN BIOTECHNOLOGY

Basic level

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Bioethics in the Field of Genetic Engineering and Genome Editing

INTRODUCTION

Bioethics in the area of the application of biotechnological methods forms a sub-area of technology assessment (TA), especially when TA is related to biomedical, food technology or agricultural fields of application. The same applies to biotechnology law, in which the application of biotechnological methods in the fields of medicine, food production and agriculture (when it comes to the breeding of crops and livestock) is legally regulated. In this context, bioethical questions are always included in the biolegal regulations when assessing the opportunities and risks associated with these methods. One thinks, for example, of possible environmental risks associated with the release of so-called "gene plants" or the question of compulsory labelling when launching foodstuffs on the market that have been genetically modified or contain components of genetically modified organisms. In these cases, it is a matter of protecting the environment as a habitat or protecting consumer interests.

The question area of TA here includes not only ethical questions in the narrower sense, but also questions of reliability and safety, as well as social and political aspects, for example by asking: "Are the social effects of a new technology politically justifiable?" For example, if it should one day become possible to extend human life far beyond the normal lifespan with the help of genetic engineering. Would this even be desirable? Are we not embarking on a fundamentally "slippery slope" that could have devastating consequences for the future of society? And what does it mean for our image of humanity if we were able to eradicate all hereditary diseases by genetic engineering or to shape or optimise the genetic make-up of human beings at will?

However, economic issues are also of bioethical and biolegal relevance, for example when it comes to the question of who should bear the costs of reproductive medical treatment (e.g. "in vitro fertilisation"), or when liability issues have to be settled in the event of a violation of property rights or personal rights. Finally, there are also aspects of data protection law: for example, if research is to be carried out on human stem cells or "genetic fingerprinting" is to be carried out for forensic purposes or genetic material is to be stored in so-called "biobanks" for research purposes. And last but not least, questions of patent law can also be ethically explosive: Can genetically modified organisms (such as new cultivated plants or "model organisms" for research) be patented at all, even though they are *living beings that are* not normal products? Or should patent protection here be limited solely to the novelty of the genetic engineering *methods*? Above all, the question also arises as to whether certain basic patents of genetic engineering methods, the development of which was often supported with public funds, should not be made available to everyone free of charge. This is the case in medicine, so why not in the field of breeding? Ultimately, only politicians can decide on this question. In short, the field of bioethics or ethically sensitive TA encompasses all "Ethical, Legal and Social Implications" (ELSI) arising from the application of biotechnological processes.

The aim of bioethics or TA is not to hinder or even prevent new biotechnological developments just because they are new, but to serve as a kind of "early warning system" that draws attention in good time to undesirable developments or ethically and socially precarious applications of new biotechnological methods. It is therefore important to include bioethical reflections in the research and development of new biotechnologies from the outset. This not only prevents ethically questionable developments, but also avoids unnecessary costs and protects the public reputation of biotechnology.

In fact, the various methods of genetic engineering have virtually revolutionised the breeding of new "transgenic" plant and animal breeds; as have, for example, the possibilities for the degradation of waste materials that pollute the environment through the use of GM bacteria (genetically modified organisms). And these methods also open up new perspectives for medicine: for example, in the field of gene therapy or gene diagnostics, as well as for the production of new (individualised) drugs in pharmacogenomics or even of certain pharmaceutical ingredients (such as the extraction of human insulin from genetically modified bacterial cultures). Finally, without genetic engineering, animal cloning would not be possible either, which also raises a number of questions of animal ethics as well as safety issues in the course of transferring "humanised" animal organs to humans, insofar as in the case of xenotransplantation disease germs dangerous to humans could jump from the donor animal to the patient. In addition to "genome editing", which enables the targeted insertion of new genes, "synthetic biology" is also of growing importance, as it allows completely new metabolic pathways to be introduced into an organism in order to synthesise new and economically interesting cell products, or even to create completely new organisms "bottom up", which is why this is often referred to as "forced genetic engineering".

The essential TA aspects thus include all questions that concern the health of humans (consumers and beneficiaries) or the protection of the environment; however, the welfare of farm and wild animals is also included, for example if they are to serve as organ donors and have to be kept under clean room conditions that are not appropriate for the species. Furthermore, it must be asked whether the populations of insects and other creatures might not suffer damage from the sowing of genetically modified plants. And specifically medical and environmental ethics are concerned with all aspects that affect the well-being of human as well as non-human living beings, so that their ethical principles and considerations are incorporated into medical and environmental policy decisions, which in turn are reflected in legal regulations.

In the LO "Bioethics", at least some of the many ethical problem areas arising from the application of biotechnology to humans, plants, animals and the environment will now be discussed in a selective manner. The following presentation will focus on questions of medical ethics, namely questions such as: "Can the release of GMOs or the application of genetic engineering in food production lead to health risks for humans?" Or: "Can the use of genetic testing methods lead to discrimination against individuals, in that findings about existing genetic predispositions to disease result in social disadvantages for those affected?" Or: "Could *genome editing* also lead to interventions in the human germ line? And what consequences could this have for the patients' offspring or for the human 'gene pool'?" Finally, the important aspect of sustainability will also be addressed, for example when biotechnological interventions are made in the environment, e.g. to secure the existence of forests in the face of climate change (e.g. by inserting resistance genes against certain pests or to increase resilience to cold or drought). In the case of such measures, which seem to make sense especially in view of climate change, genetic engineering in particular can contribute in many ways to securing the existence or also "genetic meliorisation" of forest plants, so that questions of environmental ethics are combined here with questions of sustainable protection of ecological networks (biotopes and ecosystems).

GENETIC ENGINEERING

1. Genetic engineering in agriculture: from "transgenic" to "genome edited" organisms

The history of "genetic engineering" goes back to the early 1970s, when researchers succeeded for the first time in creating genetically modified bacteria by converting ring-shaped DNA molecules naturally occurring in the bacterium *Escherichia coli*, so-called "plasmids", into gene shuttles in order to use them to introduce certain hereditary traits into the recipient cells, e.g. in yeast cells. Today, such procedures are routine in the laboratory. The molecular genetic prerequisites for this were created in the 1950s and 1960s after the nucleic structure of the genetic code was deciphered, which is universal for all living beings on earth. This universality of the genetic code allows genes to be transferred from one species to another (a process that also occurs frequently in nature itself). However, for genetic engineering interventions, it was necessary to cut the DNA into defined pieces with matching ends in order to then transfer them in a new combination to the target organism. For this purpose, so-called restriction endonucleases are used, i.e. enzymes that cut the DNA molecules at certain points; subsequently, the DNA pieces created in this way are reassembled with the help of the enzyme ligase. However, it is not quite easy in this way to insert a new gene at a specific site in the target cell and to bring it to expression there, i.e. to cause it to produce certain proteins: You need luck that this happens spontaneously in the cell, so that you simultaneously "bombard" the cell with numerous copies of the new gene, as it were - in the hope that at least one of them will insert itself in the right place.

In 1990, an attempt was made at the *Max Planck Institute* in Cologne (Germany) to produce petunias in which the genetic make-up for the salmon red flower colouring had been destroyed by a jumping gene by inserting an additional gene, which only happens extremely rarely in a spontaneous way. Surprisingly, after the experiment was completed, about 60% of the flowers had a white-red mottling. On the one hand, this result laid the foundation for plant epigenetics, in which certain characteristics are not passed on by way of mutation, but by a temporary methylation of the DNA. On the other hand, however, it also called the critics of genetic engineering onto the scene, who believed that the surprising finding was an indication of the incalculable risks of genetic engineering. The Cologne researchers had also used the *Agrobacterium tumefaciens* as a gene shuttle, of which it was already known that this bacterium can produce tumours in various plants by permanently inserting part of its genetic material into the plant chromosomes. Since then, many scientists and consumers have viewed genetic engineering with suspicion: it could be that the targeted use of such gene shuttles could not only lead to unintentional harmful changes in the target plants (such as tumours), but could also stimulate the plants to produce substances that are harmful to flower-visiting insects, for example - and perhaps even to humans when they consume these plants.

Nevertheless, the use of genetic engineering undoubtedly has considerable advantages for agriculture: for example, crops can be made resistant to certain herbicides (such as glyphosate) so that the herbicides only attack the genetically unmodified weeds in the field. Or another example: plants can be protected from insect pests by introducing genes from the soil bacterium *Bacillus thuringiensis* (Bt) into the plants that code for certain toxins, making the plants lethal or intolerant to the insects. This leads to less use of pesticides and thus also to reduced environmental pollution (e.g. of groundwater). More genetic engineering thus means less chemistry in the field, especially since normally bred plants also produce a variety of toxins that can be significantly more dangerous. Plants to which such "toxin genes" have been transferred have since been called "Bt plants" (such as "Bt maize" or "Bt cotton"). Also of great importance is the creation of the so-called "golden rice", which has a higher proportion of beta-carotene than conventionally bred rice varieties, so that it can help combat the vitamin A deficiency widespread in Asia and prevent blindness. From an ethical and social perspective, it is particularly welcome that the "golden rice" is available patent-free to all users. Nevertheless, resistance to "golden rice" has so far been so strong that it has not yet been approved for the market. Other crops, on the other hand, have been made resistant to drought or cold, or at least more tolerant, or genetically modified in such a way that they produce higher yields, which is important for securing the world's food supply - especially in view of climate change.

Around 1996, the commercial use of genetically modified or transgenic plants began, with the global cultivation area increasing from year to year: already in 2018, GM plants were cultivated on almost 192 million hectares worldwide. According to the agrobiotech organisation ISAAA, around 95% of this is in the five countries USA, Brazil, Argentina, Canada and India. Transgenic soybeans (96 million hectares), transgenic maize (59 million hectares), transgenic cotton (approx. 25 million hectares) and transgenic rape (approx. 10 million hectares) account for the largest share of GM crops. GM crops such as potato, papaya or sugar beet play only a minor role. It should be emphasised that the cultivation of these crops is not only carried out by the large agro-groups, but also by many small farmers, who often become dependent on the GM seed companies, insofar as the seeds have been made sterile by the genetic engineering companies, so that they have to be bought anew for each sowing. Although this is explained by the legitimate interest of the seed producers in making further profits in order to amortise the high development costs, it is nevertheless politically and ethically questionable, insofar as it weakens the independence of the small farmers: the traditional "farmer's proviso" no longer applies, since the farmers are forced to buy more and more seed, whereas they used to be able to save part of the harvest for the next sowing and thus did not get into debt so easily in difficult harvest years.

Legally, the situation is regulated differently in Europe: While, for example, "gentle tomatoes" are grown in Spain, the cultivation of Bt maize (MON810) was banned in Germany in 2009 because of safety concerns. And since then, no GM plants at all may be grown in Germany. But this contradicts the fact that the EU (and thus also Germany) imports a considerable amount of genetically modified feed (mainly from the USA and Brazil): e.g. around 35 million tonnes of GM soya. And the food produced with it, such as meat or eggs, does not have to be labelled. The same applies to numerous food additives such as amino acids or vitamins, which are also often obtained from genetically engineered organisms, as their production is mostly cheaper and more environmentally friendly. For the consumer, however, this is not recognisable. Moreover, in October 2019, 278 medicines with 228 different genetically produced active ingredients were approved in Germany (just think of human insulin obtained from certain bacterial cultures, which is not produced in Germany but may be obtained from abroad, although the process is even based on a German patent). Genetically modified enzymes are also found in many detergents and textiles.

Nevertheless, the acceptance of genetically engineered products is particularly low in Germany: a rejectionist attitude with which numerous consumers as well as some environmental associations stand in direct contrast to the consistently positive assessments on the part of the major research institutions, which repeatedly point to the obvious harmlessness of these products or the genetic engineering methods on which they are based. Although there are always scare stories in the media - for example that Bt maize is harmful to the monarch butterfly or can cause cancer in rats - all these "bad news" have so far been empirically refuted. There may be a certain residual risk, but the benefits of genetic engineering for agriculture are indisputable. For example, a meta-study from 2014, for which 1783 individual studies were evaluated, concluded that there was no evidence of a health risk to humans and animals in connection with GM plants (although a differentiation would have to be made between food and feed). In addition, billions of animals have been fed genetically modified feed for many years without any epidemiological studies having shown any evidence of health risks to the animals.

The discussion about the possible dangers of genetic engineering has eased somewhat since the almost revolutionary methods of so-called **"genome editing"** have become available, especially the CRISPR/Cas system first described in 2012, which was even honoured with the Nobel Prize in 2020. This is because these methods can be used to insert new genes into the genome of the recipient organism in a customised and targeted manner. So for the first time, there is the possibility of controlled mutagenesis. The CRISPR/Cas method is based on a natural immune mechanism of bacteria and archaea: If these microbes are attacked by viruses, they deposit RNA fragments from the viral genome in their own DNA. The reason for this is that they can later fight the viruses more quickly should they be attacked by them again. Because of their "knowledge" of the viral RNA fragment, they can cut up the viral RNA that enters them by means of the enzyme endonuclease and thus render it harmless. But plants also use this mechanism to render harmful viruses or fungi ineffective. And this mechanism can now also be used in genetic engineering to cut genes exactly at any point in the genome of a cell: the CRISPR/Cas9 system tracks down the target sequence of the DNA to be changed in a highly specific way, so that a chromosomal double-strand break occurs there, which is then mended by the cell's own repair systems. During this repair, however, errors can occur that inactivate the affected gene: a process that corresponds to a mutation; whereby new characteristics can also be imparted to the organism. In this way, the genome of an organism can be "edited" by specifically "switching off" certain genes so that they can no longer be translated into proteins. In the meantime, numerous crops have already been modified with CRISPR/Cas: e.g. tomatoes, soybeans, citrus fruits, maize, rice, wheat and potatoes, so that they have become resistant to various diseases, among other things. And trees, such as the poplar, can also be adapted more quickly to changing environmental conditions through "genome editing".

The decisive factor is that no foreign DNA is inserted into the genome of the organism in this procedure, so that no "transgenic" organisms are created. At the same time, this means that no foreign DNA can be detected in the organism, because the gene changes were only stimulated from the outside in a controlled way, but otherwise produced by the organism itself. Although some researchers and critics like to call "genome editing" "forced genetic engineering", no foreign "gene construct" is introduced into the cell, but only a natural mutagenesis mechanism is used, so that this case should be evaluated differently both technologically and ethically and legally. Therefore, there was great astonishment and incomprehension when the European Court of Justice (ECJ), in its decision of 25 July 2018, also allowed "targeted mutagenesis" to fall under the strict provisions of the Genetic Engineering Act, which effectively means that genome editing cannot be used as a method of "precision breeding" in Europe; whereas conventional breeding methods that use non-directed mutagenesis are still spared the rigorous requirements of the Genetic Engineering Act. While it could be argued that we have far more experience with conventionally bred plants than with GM plants, non-GM breeding methods are becoming increasingly sophisticated and refined, so the experience advantage here is also diminishing and a closer look is called for.

As long as this legal situation is not amended, genome editing for agricultural and forestry purposes can basically only be carried out outside Europe: for example, in America and Australia, where the authorities have decided to deregulate plants without foreign DNA, so that a number of plants have already been genome-edited in these countries. In the USA, for example, the genome-edited soybean *CalyxtTM High Oleic Soybean can be* sold as GMO-free. Nevertheless, there is debate about the risk of unwanted mutations as a result of genome editing, namely so-called "off-target effects". Although such effects apparently occur only rarely, various studies nevertheless call for further research. This is to be welcomed from an ethical point of view, but at the same time it is to be deplored that plant biotechnology has been so rigidly regulated in Europe that Europe could easily lose touch with research and economic development in this area.

If one looks at the current situation as a whole (i.e. also with regard to the production of transgenic plants), then the strong legal requirements to which genetic engineering processes and products are subjected in Europe seem to be exaggerated. From a bioethical perspective, it follows that a ban or moratorium on genetic engineering in agriculture is hardly justified, even if this technology is still so new that close monitoring is recommended. Also, at the very least, all foodstuffs that demonstrably contain genetic engineering components should continue to be subject to compulsory labelling - but this is less for reasons of safety than to protect consumer autonomy, i.e. the freedom of the consumer to choose between foodstuffs *with* and those *without* genetic engineering. Moreover, the question of the "patentability of life" (of GM plants, but also, for example, of "model animals" for research) remains open, as does the question of access to new GM varieties (through purchase or licensing), should the concentration of "green genetic engineering" in the hands of a few agribusinesses continue to increase. For anyone who says that mutations induced with CRISPR-Cas are basically equivalent to mutations that occur spontaneously in nature should consequently not demand *patent protection for* CRISPR-edited varieties, so that the *plant variety protection that* applies in Europe should actually be sufficient.

And of course, risk research must not rely on the fact that no health or environmental risks will become apparent in the future. In this context, however, safety research should not only focus on genetically modified varieties, but also on new varieties produced by conventional means: for here, too, methods are used (such as DNA-aggressive substances) that can lead to risky mutations in many parts of the genome. In short, while green genetic engineering appears to be "over-regulated", which also has to do with its ideologisation and certain horror fantasies (along the lines of "Frankenstein"), conventional breeding appears to be "under-regulated". However, any safety risks can only ever be adequately assessed under *real* conditions. Field trials must therefore be assessed fundamentally differently from trials under laboratory conditions (in "containment"), because it is only in "the wild" that ecological interactions can occur that cannot occur in the laboratory, since numerous components (e.g. soil bacteria, flying insects and climate fluctuations) are effective in the "field" that are not realistically taken into account in the laboratory. This is precisely why it is important to first test the ecological compatibility of GM species under real conditions (i.e. on designated trial fields) before they are widely used in agriculture. Such testing must therefore be carried out again and again for each new GM plant (which is what happens). Of course, such field trials are also carried out, but the effort to obtain permission for them is generally so great that this is *de facto* tantamount to a ban in Europe.

But even then - as far as possible - the retrievability of released GM plants should be planned for. Therefore, an authorisation of GM plants is only justified under controlled conditions, which, however, could be less strict in the case of genome-edited plants. Here, on the one hand, (a) the precautionary principle applies, according to which possible risks must be assessed in advance under field conditions before market authorisation, and on the other hand (b) the polluter pays principle, according to which the person who introduces GM organisms into the environment can always be held responsible for their health and ecological consequences. And in the case where it cannot be proven that the damage that has occurred is *not* due to the GM plants that have been applied, the operator (producer or farmer) must pay for this damage. In other words, it is not the injured party or plaintiff (such as a nature conservation organisation) who must be able to identify the polluter with certainty, but the defendant must prove his innocence in order not to be liable. This liability also applies, for example, in the event that seeds of GM plants are scattered on adjacent fields with conventional or organic cultivation, but are undesirable there and contaminate the crop yield. This reversal of the burden of proof is, of course, more an ethical requirement of fairness than legal practice already in force, so that there is still a need for regulation here (also in Europe).

In the case of ecological damage, it is also not sufficient to argue that mutations always occur in nature anyway, which is why genetically modified organisms would not be an exception. This argument does not hold water because, from an ethical point of view, natural genetic changes are to be assessed fundamentally differently from those that have been deliberately produced: here we are dealing with the side effects of deliberate *actions* and not with the purely causal consequences of random natural processes. On the other hand, the requirements for proof of the ecological safety of GM organisms must not be higher than those for conventional breeding methods, in which mutations are also produced by technical means (e.g. by ionising radiation) and subsequently selected for their usefulness. Traditional breeding even works "more blindly" than green genetic engineering (especially in the case of targeted mutagenesis by means of genome editing), which is why it must basically be classified as more precarious from an ecological and health point of view: because no one knows exactly which gene sequences, apart from the desired ones, have been altered by the breeding method (new types of proteins could now also be formed that have a toxic effect on certain butterfly species, for example).

Moreover, a *minimal residual risk* in the application of GM plants, which can never be completely ruled out, must not be misused as a "killer argument" against the agricultural use of genetic engineering as a whole. In any case, such a residual risk is completely tolerable if the balance of interests is in favour of the greater benefit of GM plants. On the other hand, opponents of genetic engineering often argue that there is no such "greater benefit", and that suitable methods of biodynamic cultivation could achieve at least as high harvest yields of equally good quality - which in turn is denied by the proponents of genetic engineering. Do we need genetic engineering in agriculture at all in order to be able to secure food for humanity in the long term and sustainably? Or could this also be ensured by means of "alternative agriculture"? This is obviously a point of contention that is likely to occupy the discussion on the "blessing or curse" of genetically upgraded agriculture for a long time to come. Be that as it may, we as a society must ask ourselves whether the potential dangers that may be associated with genetic engineering are more important to us than the opportunities we deprive ourselves of if we do *not* use genetic engineering. Certainly, the ultimate goal is to make our agricultural systems as stable and climate-resistant as possible - by whatever means. We could certainly do without genetic engineering in agriculture if we were prepared to consume more land, which in turn could be compensated for by consuming less meat. It is therefore up to us to decide which of the possible alternatives we want to choose: genetic engineering is in any case not "without alternatives". Which is why it would also be wrong to say that humanity would face starvation without genetic engineering. From an ethical and political point of view, we do have a choice, but we cannot hope for an ideal solution.

On the other hand, it is a completely different - and also ethically important - question how to prevent the globally forced production of GM products (especially GM seeds) from leading to a monopolisation of large-scale agriculture and the food industry in the long run. Therefore, in addition to conventional farming, "organic farming", which does not use any genetic engineering and is increasingly popular with consumers, should be supported by economic policy - if only to preserve the many small farms. For one problem of genetic engineering used in agriculture is that particularly high-yielding and low-cost GM plants could dominate the market to such an extent, i.e. displace conventional plant varieties to such an extent, that the wealth of available varieties is excessively reduced (i.e. the "gene pool" is impoverished) and thus the consumer's freedom of choice - contrary to his interest in diversity

- is also restricted. Nevertheless, we will probably need genetic engineering to improve the world food situation as a whole and to reduce environmental pollution.

Bioethical perspective: Biotechnology in the sense of "genetic engineering" is a very valuable instrument when it comes to making better use of existing biological resources and developing new ones. In doing so, however, it must not only serve short-term profit interests by contributing to the acceleration of private economic growth, but it must above all serve the achievement of long-term and sustainability-oriented goals in order to both protect nature and secure the future of humanity (which both belong together).

2. Genetic engineering for medical purposes: germline gene therapy, genome analysis and pharmacogenomics

GERMLINE GENE THERAPY

First, let us look at the possibility that "genome editing" could be used for germline gene therapy in humans. Until now, only so-called "somatic gene therapy" for the causal treatment of monogenetic diseases (such as haemophilia, cystic fibrosis or muscular dystrophies) seemed to be possible and ethically unobjectionable, provided that the safety problems could be controlled: for example, tumours must not be formed, as only the hereditary defect present in the body cells (e.g. blood or liver) is actually corrected. Genetic germ line therapy, in which the reproductive cells (egg or sperm cell) are irreversibly altered, was regarded worldwide as inadmissible because, in view of the wide dispersion of the "therapeutic genes" introduced, new hereditary defects could easily occur which would now be passed on to subsequent generations. With the precise methods of "genome editing", however, this risk seems to be controllable *prima vista*. The genetic interventions could be carried out on the gametes or on early embryos. By means of such interventions, not only breaks in the DNA strand can be induced at certain points, but also individual nucleic bases (the building blocks or letters of DNA) can be converted or replaced - and this can be done in a relatively inexpensive way. In this way, certain genes can not only be inactivated, but also normally "silent" genes can be activated to perform those services that were prevented due to the hereditary defect. In fact, in the case of hereditary defects that affect larger parts of the organism (such as the entire liver), it is difficult or even impossible to reach all the body cells affected by the hereditary defect, so that the targeted modification of the germ cells must appear to be the "method of choice".

The fertilized egg cell forms, so to speak, the first totipotent stem cell from which all body cells - however functionally different they may be - are derived: if this is successfully modified, then all body cells will also be modified accordingly, since all body cells contain the same set of chromosomes. The spectrum of "targets" for germline gene therapy is very broad: in addition to the classical hereditary diseases, chronic infectious diseases such as HIV/AIDS could also be treated, and immunotherapies against cancer could be improved. Therapeutic options open up in particular (a) for preventing the transmission of monogenic hereditary diseases in couples for whom pre-implantation diagnostics (PGD) for the purpose of embryo selection is not promising (for example, in the case of Duchenne muscular dystrophy or lysosomal storage diseases), (b) for the prevention of disease risks that can be traced back to certain gene variants (polymorphisms) (as in the case of breast and ovarian cancer), or (c) for the treatment of infertility when embryos no longer reproduce after in vitro fertilization (IVF) due to individual gene defects. At present, projects aimed at improving (enhancing) certain characteristics through germline interventions appear to be very unrealistic: on the one hand, the molecular genetic mechanisms underlying complex characteristics (such as intelligence) are still largely misunderstood, and on the other hand, there is no medical indication for this, so that from a bioethical and socio-ethical point of view one must ask whether such "enhancement" is at all desirable or should be permitted.

In addition, it has been shown that "genome editing" has so far not been able to achieve 100% reliable changes in the genome - after all, there have always been undesirable off-target effects that entail risks of disease. This is partly due to the fact that researchers have so far only been able to control the cell's own repair mechanisms, which take effect at the DNA breakage sites, to a limited extent, so that unplanned insertions or deletions of genetic information can occur. In the meantime, however, the new procedure of "prime editing" is raising certain hopes that this control could succeed after all (but it has only been tested in the laboratory so far).

More bioethically relevant is the criticism that germ line interventions could violate the right to self-determination of the still unborn offspring, who may not even want these "corrections". In addition, they could be subjected to unreasonable monitoring measures to check the safety of the intervention carried out on their ancestor. It is also feared that such a fundamental intervention could call into question certain basic preconditions of human coexistence, because it is no longer possible to assume that all human beings are natural. On the other hand, germ line interventions could also help individuals to realise their reproductive autonomy, i.e. to make self-determined decisions about their own reproduction, e.g. in cases where germ line interventions are the only way to give birth to genetically related children without hereditary diseases. At the societal level, moreover, the fear could arise that germ line interventions contribute to the establishment of normative ideas regarding the genetic make-up of humans, which lead to discrimination against genetically modified individuals. Finally, a number of experts doubt the fundamental permissibility of interventions in embryos for research purposes or for clinical reasons, since such interventions would violate the unconditional protection of embryos.

This became clear when, in November 2018, a Chinese research team not only carried out gene manipulative experiments on embryos, but also implanted these embryos in a woman who then gave birth to twins. The aim of this operation was to make the children resistant to infection with the HI virus by imitating a naturally occurring mutation in a certain gene (CCR5). However, it is still not clear whether or to what extent this was achieved. There was unanimous condemnation of this first germ line intervention by means of "genome editing", as this intervention was carried out without the necessary knowledge about its safety and consequences and without taking into account the applicable medical ethical standards (which include, for example, sufficient information of the test person in consideration of other possibilities of protection against an HIV infection). The three researchers responsible were sentenced to prison by a Chinese court.

In the aftermath of this incident, two international scientific commissions were set up, among others, to clarify, on the one hand, the conditions under which clinical application of germline interventions is justifiable and, on the other hand, to explore how global regulation of such interventions could be undertaken. The result of these deliberations was the drafting of a "Consensus Report", which stated that the criteria for efficient and reliable genome interventions are not currently met and that both further research and a broad societal debate on this issue are needed. As far as research into germline gene therapy based on "genome editing" is concerned, new options could emerge through it in three areas in particular: (a) the performance of genome-wide screenings, with the help of which the function of genes and their products in cellular and medically relevant processes within various human cell tissues can be investigated; (b) the production of disease models in animals and human cells, whereby pluripotent stem cells and organ-like systems ("organoids") could also be used as models here; and (c) in vitro experiments on early embryos in order to gain knowledge about early human embryonic development. However, a country like Germany could only participate in such experiments if the ban on experiments on embryos were lifted first, for which again a broad social debate is necessary.

Germline therapy with the help of "genome editing" is still in its infancy. New methods are being invented all the time: a German research team has recently succeeded in "designing" certain sequence-specific recombinase enzymes (SSR) with which a specific target region in the genome can be tailored in such a way that practically all genetic diseases can be addressed. And that is just the beginning. The bioethical evaluation of possible risks and socio-economic consequences will therefore not run out of tasks in this field any time soon.

The formation of opinion that is at stake here can be accompanied and promoted by philosophically based bioethics, but not decided in advance. Should a majority of people accept germ line experiments, then it would be necessary to insist that these experiments be clearly regulated by law and supervised by competent institutions. This is not only to prevent a "proliferation" and to protect patients from hasty clinical trials, but also to avoid discrediting research on the human genome and damaging its positive prospects (as has already happened to some extent as a result of the Chinese incident mentioned above). In principle, there is as little objection to a tendency to eradicate serious hereditary diseases as there is to the eradication of dangerous infectious germs (such as smallpox), but this must neither violate personal rights nor affect social peace, for example by leading to "genetic discrimination" against germline-treated people or their descendants.

GENOME ANALYSIS

Finally, the application of genetic engineering methods to the study of whole genomes should be considered: that is, to so-called "genome analysis". Genome analysis is, to a certain extent, the other side of "genetic engineering": because here genetic engineering is not used for the constructive ("engineering") modification of given organisms (or even - as in "synthetic biology" - the production of completely new organisms is aimed at), but genetic engineering is used to break down gene sequences, for example, to discover genetic polymorphisms and to detect medically significant hereditary defects. Of particular importance is *functional genome* analysis, which not only attempts to describe the structure of an entire genome or specific gene segments, but also seeks to elucidate the cellular or organic function of individual genes and their functional interaction, for example, to determine their contribution to specific metabolic processes or to explain the causes and course of specific hereditary diseases or organic dysfunctions. Genome-analytical methods are thus relevant both for agriculture (e.g. through the gene sequencing of wild plants of interest for cultivation purposes) and for human medicine: be it in the elucidation of mono- or polygenetic dispositions that can trigger certain ailments, or be it, for example, in the development of vaccines that can be used to treat diseases. in the development of vaccines, for example, in that these methods provide information about the gene structures of pathogens such as viruses or bacteria, which could be the starting point for medical interventions (e.g. the *Pfizer-Biontec* company would not have been able to develop its RNA vaccine without gene sequencing of the Corona virus).

While genome analysis for the elucidation of bacterial, plant and animal genomes can be classified as harmless, and even extremely useful, some ethical questions arise in the case of its application to the human genome - especially if the genome analysis relates to a specific person, so that their personal rights could be violated.

questions about the social and ethical implications. Negative and positive expectations preoccupy scientists and the general public alike. The *fears* can be summarised with the concern of a "transparent human being" and a "human being made to measure". The *hopes are* directed towards a gain in knowledge both with regard to the human generic nature and the constitutive factors of human individuality As a project of profound significance for human self-understanding and with far-reaching application possibilities, the analysis of the genome is associated with a multitude of, but above all opportunities in the field of medical diagnostics, prevention and therapy. Unlike other large-scale scientific projects, research into the genome was subjected to critical reflection on its possible consequences at a very early stage, especially by the scientists involved. Attempts to network and increase the efficiency of genome projects are at the same time striving to deal with and clarify ethical issues. The most important principles that play a role here are the protection of the integrity of the person, self-determination and freedom of research (UNESCO 1996; Council of Europe 1996). They are all based on respect for human dignity. However, the extent to which concrete norms can be justified by human dignity is disputed in ethics as well as in jurisprudence. Insight into the molecular structure of the genetic code is expected to provide opportunities for targeted intervention. Despite the interconnectedness of basic knowledge and practical application, one will have to distinguish in ethical analysis between an appreciation of genome analysis as a project of basic research and the possibilities for action arising from it with regard to individual diagnostics on the one hand and possibilities for intervention on the other.

The term genome refers to the *totality of the genetic information of* an individual or species. Genome analysis" is the study of the primary structure (DNA sequence) of the genome. Within the framework of the international genome *project* coordinated by the *Human Genome Organisation (HUGO), the* aim is not to compile the DNA sequence of a single individual, but rather to compile a *canonical* human DNA sequence from many individual individuals. The discussion of ethical, legal and social issues in applied human genetics focused as early as the 1960s and 1970s of this century on the newly developed possibilities of conducting population-wide screening for genetic traits. Today, this topic is more than ever in the focus of controversy, as the genome project is steadily increasing the potential of this field of application. Let us now look at some aspects of genome analysis that are particularly interesting from an ethical point of view.

(a) Genetic screening

Genetic screening" is the search for genotypes (genetic predispositions) in a symptom-free population that lead to increased risks for genetic diseases in their carriers or their offspring. Genetic screening is one of those investigations where doctors do not wait for people to come to them of their own accord because of current or feared future conditions, but rather the health service actively approaches the population of its own accord. Genetic screening programmes which, under cost-benefit considerations, aim to intervene in the reproductive freedom of individuals under a social objective, are implicitly to be seen as eugenically motivated and are therefore to be rejected.

Genetic screening finds its ethical and health economic justification in a population-wide intended *disease prevention*. If the development of a disease is prevented by suitable means due to early knowledge of the risks, then this is called "primary prevention". A classic example is vaccination against an infectious disease. One also speaks of primary prevention when one eliminates the main causes of diseases that develop multifactorially: a programme that helps one to give up smoking serves as primary prevention of lung cancer and coronary heart disease.

The medical benefits of screening are offset by the risk of social **discrimination** against carriers of genetic diseases. This risk is particularly present in the *insurance industry* and in the *workplace*. Unlike in a purely medical context, genetic screening of policyholders would no longer be carried out primarily for their benefit, but rather for that of the insurance company or the community of all policyholders. Insurance companies might want to avoid the danger of *anti-selection* through genetic screening. The AIDS test for insurance applications, which is already common today, could serve as a precedent. Job-related employment tests also usually have two sides. On the one hand, they could be used to detect conditions that put some applicants in specific jobs at greater risk than others. Those at risk would then be protected from illness by not being hired, but on the other hand they would have the disadvantage of not having found a job.

Early genome analysis is permitted on the basis of a medical indication with the consent of the parents or guardians. Indicated are all treatable diseases and those that may become treatable in the course of the child's life. As research into the human genome progresses, DNA analysis enables comprehensive newborn screening, i.e. the detection of diseases that cannot be treated. However, the detection of such diseases contradicts the purpose of the examination, which is to prevent serious damage to health by treatment immediately after birth, and should therefore be rejected. If the child has grown up and wants to be informed of the result of his or her early genome analysis, this requires his or her consent.

(b) Mapping and sequencing

According to the prevailing view, determining the exact structure of the genome is not in itself a goal that poses problems from the perspective of ethics. It is one of the fundamental characteristics of human beings that they strive for knowledge (Aristotle),

and knowledge of oneself has a prominent place in this. Therefore, with regard to research into the human genome, the principle of freedom of research will be given precedence over a verdict against theoretical curiosity.

concede. Possible problematic consequences associated with genome analysis do not justify preventing or hindering research. Whether the project of mapping and sequencing the human genome is ethically forbidden, permitted or required is therefore mostly negotiated under the question of the justification or necessity of public funding. The main point of contention is whether a complete sequencing of the genome ("total sequencing") makes sense in terms of research policy or whether one should limit oneself to those parts of the genome that carry genetic information according to our current state of knowledge.

(c) Genetic make-up of the individual and genetic testing

Genome analysis not only provides insight into the blueprint of the species, it also forms the basis for understanding individual characteristics. Great importance is generally attached to the shaping of individuality through genetic make-up. However, the prognostic value of the knowledge about this endowment should not be overestimated. Genes provide information, but not a definitive text of life; only a few traits are clearly and unalterably fixed. The phenotypic unfolding of the individual takes place as a historical process in confrontation with the environment. Concerns about a determinism of life are therefore unjustified. Nevertheless, knowledge of genetic dispositions enables predictions of hereditary diseases and knowledge of existing individual health risks. This knowledge is problematic because it can generate fear of one's own future - whether because an illness is fatefully imminent or because dealing with probabilities makes life planning more difficult. Furthermore, access to this knowledge by others can mean disadvantages or dangers for the individual. Knowledge about non-disease-related predispositions ("normal characteristics") also opens up new problems of dealing with prognostic knowledge and the protection of personal data. The collection of knowledge about the genetic make-up of the individual therefore requires its own justification. In this context, reference is made to the right to self-determined handling of genetic information, which is part of the free development of the personality.

This is expressed both in the right to know and in the right not to know. Apart from a few exceptional cases, a test is therefore only permitted with the prior consent of the person concerned.

(d) Data protection

Data protection is also mostly justified by ethics with the right to informational self-determination. The special protection of genetic information results from the assumed proximity between the person and the genome. Nevertheless, genetic knowledge cannot be attributed to the unlimited ownership of the individual. On the one hand, it is argued that information has the character of exchange. More important seems to be the reference to the legitimate interests of third parties. The genetic examination of suspects ordered by a court to establish their identity and the genetic determination of paternity in the context of a court case are indisputable. In both cases, the avoidance of information overload is required from an ethical and legal perspective.

Far more problematic is the question of whether **insurance companies** have legitimate interests in obtaining information about the genetic dispositions of insured persons in order to use it in determining risk. The Council of Europe's Convention on Human Rights in Biomedicine provides in this regard, as well as with regard to the area of the labour market, that predictive genetic tests carried out to forecast diseases or to determine a disposition to disease may only be used for health or health-related scientific research purposes (Council of Europe 1996, Art. 12). In addition to the role of the concept of disease, it must be clarified how the self-determination of the individual and the social interest in prevention are to be weighted in the future. Mostly, it is demanded that consent must be given for genetic testing as well as for collective genetic screening where it cannot be formally assumed. In any case, screening should only be carried out for diseases that can be treated or for which preventive measures are possible. It is questionable whether this principle is also applicable to genetic tests in the prenatal phase, where the possibility of abortion exists. Although the abortion of a damaged foetus is justified under German law only by the physical and psychological burden on the mother, the danger of discrimination against disabled children or their parents as well as the danger of eugenic tendencies cannot be excluded. Heterozygote screening also comes into question with regard to non-therapeutic diseases. In addition to the option of termination of pregnancy, there is also the option of refraining from procreation as well as the option of choosing a partner with regard to the genetic carrier. As in the case of prenatal diagnostics, the voluntary nature of the examination must also be demanded here.

(e) Therapeutic use

An appropriate ethical assessment of genome analysis must take into account the therapeutic application possibilities. Despite all the difficulties of implementing the knowledge, this is the decisive justification for all research efforts. Criticism of genome analysis is also essentially based on the concern that human beings could be robbed of their natural determinacy and subjected to changing social objectives or questionable parental preferences. The difficulty of an appropriate assessment lies in the many unanswered questions regarding the resulting concrete risks and opportunities. It is also open in what way the project of genome analysis will affect our understanding of disease and health and to what extent there is a danger of identifying both in view of the connection between genetic disposition and disease. The emerging possibilities for intervention must be judged in an ethically differentiated way. A distinction must be made between surgical interventions, somatic gene therapy, germ line therapy and non-disease-related interventions ("enhancement genetic engineering").

PHARMACOGENOMICS

In the following and in conclusion, pharmacogenomics will be presented, which can be regarded as a special application of genome-analytical or gene-diagnostic outcrops and whose potential benefits clearly outweigh its possible dangers or disadvantages.

The pharmaceutical industry has been paying increasing attention to the possibilities of DNA diagnostics for many years. This is reflected in their strong commitment to the functional elucidation of the human genome in particular. Indeed, without the diagnostic elucidation of the genetic basis of protein synthesis, there would be no genetic production of biopharmaceuticals. Often, it is only when the gene sequence is known that corresponding protein domains and their associated functions can be deduced. The genetic sequencing and cloning of the specific nucleic acid segment that codes for a specific therapeutically interesting gene product (an enzyme or a structural protein) in the genome of the living organism is the prerequisite for enabling industrially usable foreign organisms (such as bacteria) to express precisely this desired gene product in sufficient quantity and high purity by means of suitable gene transfer techniques. This makes it possible to obtain pharmacologically highly specific and highly effective active substances by genetic engineering: think, for example, of the blood coagulation factor VIII, the hormone erythropoietin, human insulin or certain interleukins and growth factors such as G-CSF. DNA diagnostics in the sense of elucidating the structure, function and regulation of genes is thus becoming an important tool in modern bio-pharmaceutics.

Already since the beginning of the 1990s, therefore, a new segment has emerged within the biotech industry, which is referred to as the "genomics" sector and can in some ways be seen as an economic offshoot of the international "human genome project". The companies in this sector (e.g. *Genset* in France and *Myriad Genetics* in the USA) deal with the detection, sequencing, cloning and functional elucidation of economically especially pharmaceutically interesting gene sequences of humans, but also of microorganisms, which can serve as "targets" for the development of new pharmaceuticals. First of all, it is important to secure patents on gene sequences that appear to be commercially valuable: one example is the discovery of breast cancer genes, on the basis of which - various genetic tests have been developed and are already being marketed.

With regard to the enormous variance of the gene pool within a country's population, three complexes of questions in particular are increasingly attracting the interest of pharmacologists, toxicologists and genetic epidemiologists:

- To what extent are genetic dispositions involved in the development of complex diseases (e.g. cancer)?
- Are there genetic reasons why different patients react differently to the same medicines, i.e. sometimes more, sometimes less responsive to these medicines or suffer side effects?
- What role do genetic factors play in different sensitivities or resistances to environmental pollutants?

Many experts are certain that the detection of certain *genetic variants*, so-called SNPs ("single-nucleid polymorphisms"), which are significant for pharmacokinetics and pharmacodynamics, will - significantly change the way many drugs are developed and distributed. In contrast to the traditional "one-medicine-fits-all" strategy, pharmacogenomics is expected to lead to the development of more specific drugs based on a deeper understanding of the relationship between genetic variability and different medication outcomes. With the help of so-called *pharmacogenomics,* it seems possible for the first time to understand why different patients react, sometimes considerably differently, to one and the same drug. At the same time, the future genotyping of patients should make it possible to predict the individual effect of an administered drug and to stratify the patient population into subpopulations in such a way that optimal medication can be guaranteed. The goal is to tailor or dose each drug to suit the patient's genetic characteristics - for example, in terms of how they metabolise a drug or which genetic defect of several possible ones should be "compensated" for.

Pharmacogenomics is, in a sense, a synthesis of functional genomics and molecular pharmacology. It is not concerned with the search for genes or gene mutations that are (partly) responsible for the occurrence of a certain disease, but attempts to identify potential targets (proteins) for drugs and to research individual variabilities of the coding genes. This is intended to identify populations that benefit particularly from a specific medication.

SNPs are distributed across the entire human genome. Even if about 99.9% of the approximately 3 billion nucleotide pairs of the human genome match in all people, the remaining - "variable" - rest of about 0.1% should not be underestimated, neither in size nor in medical significance: one SNP every 1,000 bases still results in about 150,000 SNPs that need to be identified. SNPs are one of the reasons for the occurrence of genetic polymorphisms, which in turn result in enzymes with partly reduced, partly absent activity, sometimes even "nonsense proteins". With the help of SNP maps, different SNP patterns characteristic of different patient groups can be identified, so that certain conclusions about the genetic profiles underlying the different sensitivities and drug reactions would be possible. In view of several thousand suspected transport proteins alone, many of which are significant for the uptake, distribution and excretion of drugs, a veritable flood of new pharmacogenetically relevant transport polymorphisms can already be expected in the near future. The same applies to the elucidation of receptor polymorphisms that modify the structure and function of the body's own drug targets.

Different gene variants are responsible for how well, for example, the drug pravastatin lowers cholesterol levels, procainamide helps with cardiac arrhythmias or albuterol works for asthma patients. Statistically, almost every fourth patient reacts particularly strongly to certain drugs, so that an individually tailored dosage would be desirable. In this way, pharmacogenomics can contribute significantly to the "personalisation" of medical therapy. It is expected that in the near future more and more drugs will be marketed in combination with test kits for differential genotyping of patient populations. If it is true that up to 85% of an individual's response to a drug is determined by genetic make-up, then the development of SNP test kits could well have a dramatic impact on the pharmaceutical market and medical prescribing practices. Such test kits, mind you, are not about *predicting* disease, but about *predicting* the therapeutic success of a drug: they predict how a patient with certain genetic characteristics will respond to the drug and then what the likely course of the disease will be.

Many *medical advantages of* pharmacogenomics are obvious:

- patients who are sensitive to side effects of drugs can be quickly identified and selected;
- the costly monitoring of patients with regard to possible toxic effects of the administered drugs can be reduced considerably;
- a high and cost-saving effectiveness of the therapy is achieved right from the start, especially since the optimal substance in its optimal dosage can be found quickly;
- a reduced number of visits to the doctor is necessary;
- costs arising from the prescription of ineffective medicines (as well as from the treatment of side effects caused by them) can be avoided, as adherence increases;
- the treatment of patients can be safer, more effective and more tolerable overall than before if it is individualised and risk-adapted;
- reducing the burden on patients participating in clinical trials and improve the likelihood of success of investigational medicines.

However, the full significance of pharmacogenomics only becomes clear when one considers some *specific areas of application* such as

- the treatment of *infections*: the rapid genotyping of viruses (think of hepatitis or AIDS) or bacteria allows the doctor to select the most promising individual therapy in each case (which is particularly important if resistant strains of pathogens have to be detected in the patient in good time);
- therapeutic or preventive measures in *oncology*: here, genomic analysis allows, for example, the detection of a patient's resistance to certain chemotherapeutic agents (such as cytostatics) or an early diagnosis of primary tumours or (micro-) metastases through the detection of tumour markers, p53 mutations, etc;
- the *differential diagnosis of* symptomatically complex clinical pictures: polygenetic diseases such as Alzheimer's disease, schizophrenia or hypertension are based on very different molecular mechanisms, which require correspondingly different treatment methods.

Overall, the findings of pharmacogenomics could be of great importance for numerous drugs, which in turn relate to a broad therapeutic spectrum: from cancer therapy to the treatment of cardiovascular and neuropsychiatric diseases and the fight against infections.

However, the pharmacogenomics approach also poses *ethical and legal problems with* regard to the handling of incriminating genetic information and data protection. One important point is the preservation of confidentiality in dealing with the genetic information obtained. It is also conceivable that patients who are likely to be difficult to treat because of their pharmacogenetic test would have to pay higher health insurance premiums. It could also be psychologically difficult for the pharmacogenetically tested person and their relatives if the test should also reveal that there are other risks of disease that may be incurable.

Bioethics in the Field of Environment (Nature)

INTRODUCTION

Environmental ethics forms a sub-field of bioethics. It deals with all aspects of human intervention in nature or, as one might say, in "socio-ecological systems", by considering and evaluating the complex interrelationships between the natural environment on the one hand and social human systems on the other. In this context, the technical interventions of humans in the mining development of valuable resources (such as ore deposits, energy sources and water), in the agricultural and forestry use of land and in the construction of an infrastructure of settlements and roads are of particular importance. The environmental impact of humans, especially with the help of biotechnological methods, is still relatively small, but in the course of the growing entry of biotechnology into agriculture, for example through the sowing of genetically modified plant seeds, the effects of biotechnology on nature are becoming more and more noticeable. In order to be able to evaluate these effects bioethically, it is necessary to be clear about the significance of nature for social life. What is nature anyway? And what is our relationship to it? Finally, what about nature is worth preserving and protecting? And why? Are the questions of ethics not limited to the human sphere or do certain phenomena of nature - such as animals, plants and biotopes - also have an intrinsic ethical value that must be respected by humans?

This LO will therefore deal with all questions related to the inherent value of nature and thus also concern all questions that arise with regard to human behaviour towards nature, with particular attention to (bio-) technological interventions.

The subject of environmental ethics is the reflection of those conditions, structures and processes that make it possible for man and society to deal with the network of nature that supports them in a way that is responsible for the future in the face of practical reason. The intensive discussion since 1970 about the limits of the technical-industrial paradigm of progress has brought the irrefutability of such an endeavour into the public consciousness. Numerous sociogenic hazard potentials threaten both the natural living conditions of humans and the natural ecosystems that have hitherto been independent of them. Thus a stage of social history has been reached in which the question of self-limitation of a technical-industrial civilisation arises as well as the task of redefining the standards of responsibility, safety, damage limitation and imposition of damage consequences achieved so far with regard to the ecological hazard potentials. The success of such efforts depends on whether the dynamics of the productive forces unleashed in modernity can be used in a way that leads to a non-destructive relationship between society and nature.

The future viability of the technical-industrial civilisation can only be ensured if regulations are observed which nature itself prescribes. This includes, above all, the overall interconnectedness of all structures and processes in the social living world of man and his natural environment. The ethical discussion of the ecological problem must also methodically correspond to this interconnectedness by passing through various stages of reflection that are in relation to each other in the form of progressive complementation and mutual preconditions:

a) Reconstruction of the social relations of nature:

Modern societies are forced to arrive at a perception and description of nature that is an integral part of their self-perception and self-description. A theory of nature is needed that allows it to be understood as socio-culturally co-constituted. In this "socialised nature", the objective preconditions of a social practice are then to be uncovered, which at the same time follows a rationally guided path of social evolution.

b) Justification of a social-ecological moral principle:

The ethical normativity of regulative structures in a society's relationship to nature is to be demonstrated by referring to generally understandable moral principles qua principles of reason. In doing so, however, an empirical-analytical approach must be taken in order to preserve the relationship of environmental ethical reflections to the specifics of their subject matter.

c) Operationalisation of environmental ethical principles:

The structure and application of environmental ethics must be compatible with the plausibility standards and functional conditions of existence of complex societies. The content of actions, values and norms to be realised by all members of a society can only result from procedures by which all participants can reasonably come to classify something as generally desirable and commit themselves to certain behavioural parameters. Particular importance for the operationalisation of environmental ethical parameters (e.g. sustainability, individual and social compatibility) is attached to the determination of rules and processes for the weighing of goods, impact assessment and risk assessment of technical interventions in nature.

Nature exists only as an evolutionary variable. It does not represent a static order that is fixed once and for all, but is itself determined by ever new developmental thrusts and changes. What presents itself on the one hand as "natural equilibrium" results from conflictual evolutionary processes. And what on the other hand still appears to be a product of natural evolution has in fact long since become part of a "socialised" nature. In technical-industrial societies, it is possible for the first time to influence biological evolution through targeted intervention in the genetic code, thus reversing the original dependencies between socio-cultural and genetic-biological evolution. Nature is less and less something existing by itself, but cognitively and practically more and more the result of access to it, i.e. it is culturally co-constituted. Culture, in turn, is part of that nature which it co-constitutes. The biological-physical environment (biosphere) thus no longer forms an outside of the social life-world (sociosphere).

The decisive question is rather under what consideration it is an imperative of practical reason to recognise nature as a norm for the shaping of the social. In this context, it is no longer possible to refer to a metaphysically constituted nature and to search for inescapable conditions of human coexistence beyond history and empiricism. Rather, the ethical and political discourse must be extended to those moments of the unavailable, the unavailable and the unaccountable that place social action under an ethical claim within a socialised nature. This already indicates the right and limits of physiocentric and pathocentric approaches to environmental ethics. Both draw attention to a decisive deficit of traditional "anthropocentric" morality. This only allowed members of the human species the claim never to be treated merely as means, but always also as ends in themselves. There is no doubt that the value of nature is not exhausted in the aspect of usability for man. But the aesthetic, mystical or ontological quality claimed for nature as such can never be detached from its relation to the specific forms of experience and perception of the human subject.

The fact that humans are a part of nature and, like animals and plants, are integrated into a system of ecological dependencies does not eliminate the difference that distinguishes natural beings with the capacity for self-consciousness and for reflecting on this consciousness from natural beings without these capacities. Physiocentric and biocentric approaches, which ignore all characteristics except organismic-biological aspects, do not do justice to this circumstance. But it is precisely the human capacity for reflection that constitutes ethics. It is not norms that are embedded in nature, but the ethical reason of man, which has to decide on those norms that allow human life to succeed in the recognition of its natural regulative. Man himself is nature, his moral integrity is dependent on the integrity of his physical nature.

Against this background, an ethics that strives to secure the personal-social existence of human beings neither desensitises us to non-human life nor degrades nature to a mere storehouse of raw materials. The integrity of human life depends on nature, whose integrity in the modern age, however, depends on man. Conservation of resources and responsibility for the future, respect for the intrinsic value of nature, the demand for empathy in the face of suffering living beings, are certainly contents that are compatible with such an "anthroporelational" approach. With regard to the formation and social implementation of an environmental ethic, the orientation towards the carrying capacity of nature must be concretised on the basis of further criteria for assessing the individual or social and environmental compatibility of socio-economic objectives and measures. Where the effects of human action do not become counterproductive within the carrying capacity of nature and its ecosystems, they can be considered "environmentally compatible".

The demands for environmentally and socially compatible action cannot be discussed independently of each other. In the narrower sense, measures that serve the realisation of the ethical project of modernity are to be classified as "individual" or "socially compatible": social safeguarding of individual freedom, overcoming of violence and exploitation, establishment of social justice and international solidarity. Included in the postulate of social compatibility is both the responsibility for the life chances and rights of present and future generations and the task of paying attention to the "natural" conditions for realising these goals.

Whether an environmental ethic can ultimately be behaviour-oriented is measured by whether it can provide the necessary balancing services in concrete decision-making problems that are characterised by competition and conflict of different interests, value convictions, etc. Such situations are constantly increasing in complex societies. Such situations are constantly increasing in complex societies. If divergent goals of action are given and negative side effects or risks have to be accepted, a special procedure of weighing up goods and evils is required. The social relevance of environmental ethics depends essentially on whether it can offer appropriate rules for such a procedure that are compatible with the basic socio-ecological principles outlined above.

The successful social implementation of environmental ethical norms largely depends on their being incorporated into the political-economic framework of a society. This should be designed in such a way that wherever possible, environmental ethical claims do not have to be enforced against the functional logic of the economy, for example, but can be translated into it. Using ethical arguments to call for an environmentally friendly economy only makes sense if general compliance with the required behavioural maxims is sufficiently ensured. Economic actors must therefore be offered incentives for action that are compatible with the logic of competition and the market. This is most likely to be possible through an appropriate arrangement of the economic framework, whereby the profit calculations of competing companies are influenced in such a way that it is economically "worthwhile" for all to behave in an environmentally friendly manner. Economy and technology can only produce environmentally and socially compatible effects if their forces unfold within the framework of such an order of action, which is subordinate to them.

THREE CENTRAL TASKS OF ENVIRONMENTAL ETHICS

Every ethics has to do with the determination of values that must be observed so that a certain action can be considered morally justified. A particular problem in the application of values arises from the fact that it is not necessarily clear what may or must be included in the "moral universe". Environmental ethics also has to deal with such a problem of application. Environmental ethics is applied ethics. Its validity depends on whether or not the environment of human society - i.e. nature - has any moral intrinsic value at all. That nature is valuable to humans is undisputed. But does it as a whole, or do at least certain natural entities, also have a "value in themselves", just as one ascribes a value in themselves to human beings as such? In other words, does nature or certain natural entities have an intrinsic (absolute) value or only a relative (derived) value in relation to the well-being of human beings (be it of a particular human individual or be it of human society as a whole)?

In any case, many environmental ethicists are of the opinion that certain entities in man's natural environment must be accorded such an autonomous value that should be respected in our dealings with them. But even if one is content to ascribe an indirect value to nature only in relation to humans, to their needs and interests, environmental ethics poses a challenge to the ethical, political and economic behaviour of humans towards their natural environment, insofar as an area is addressed in which new forms of weighing up goods occur: for example, how to deal with scarce natural resources (e.g. fossil fuels). For example, how to deal with scarce natural resources (e.g. fossil fuels), whose thoughtless waste can lead to a state of emergency for future generations - the interest in immediate use comes into conflict here with the interest in provision for the future.

Altogether, three forms of environmental ethics can be distinguished, which together form an ascending sequence, insofar as each successive form includes the preceding one or extends it by additional "moral agents": (1) resource ethics, (2) animal ethics and (3) natural ethics.

1. Resource ethics

In the case that nature is only attributed a value in relation to humans, we are primarily dealing with questions of "resource ethics". Resource ethics is certainly only environmental ethics in the narrower sense, but is nevertheless always also a component of any broader environmental ethics. Resource ethics places people at the centre of its interest by subjecting aspects of dealing with scarce, consumable or destructible resources and environmental media such as water, soil and air to ethical considerations. In particular, it also deals with "renewable biotic resources" such as forests and fish stocks.

But the question of a dangerous change in the earth's climate also belongs to the area of resource ethics. Last but not least, this form of environmental ethics also includes so-called "agricultural ethics", which deals specifically with questions of landscape and soil change through agriculture. It is precisely the agricultural use of the environment that repeatedly causes serious environmental damage. Resource ethics thus asks how we may use the raw materials and environmental media (such as water and soil) provided by nature without this leading to unreviewable damage (overuse, pollution, etc.). Such ethics can still be justified exclusively anthropocentrically, i.e. from the point of view of human interests.

2. Animal ethics

Animal ethics is concerned with the welfare of individual pain-sensitive living beings. Since animal ethics is mostly concerned only with pain-sensitive organisms, the term "animal ethics" is somewhat misleading. It divides the animal kingdom into animals with a nervous system and those that lack pain sensitivity because they do not have a nervous system. The guiding premise here is that the existence of a nervous system is a necessary precondition for the ability to suffer. In any case, animal ethics considers the relationship of humans to all those natural beings that we may assume are capable of suffering like ourselves. With creatures capable of suffering, however, we can feel empathy and compassion. In addition, such creatures have a pronounced instinct for self-preservation - in a sense, they pursue -interests, seek satisfaction and strive to avoid suffering and unpleasantness.

Organisms that have an interest in themselves, however, appear to be morally valuable to a special degree, since they must be granted a certain autonomy in their behaviour. This applies not only to the great apes, which are our closest relatives in the animal kingdom, but also to all non-primate animals, provided that they are sensitive to pain and apparently consciously perceive themselves and their environment. Animal ethics thus asks whether animals - at least sentient ones - have a value and purpose in themselves. And if so, what this means ethically with regard to our relationship and behaviour towards them. A consistent animal ethics goes beyond a purely anthropocentric approach by thinking "pathocentrically".

3. Natural ethics

Natural ethics deals with the moral aspects of dealing with lower "insentient" living beings (plants, fungi, bacteria, etc.) on the one hand, and with supra-individual biotic entities such as species, biocenoses, ecosystems and landscapes on the other. As an "ethics of preservation" or "conservation ethics", it addresses questions of the preservation of natural areas from destruction by humans. In this sense, it also makes a contribution to the protection of civilisation in relation to the environment. As an "ethics of nature" in the narrower sense, it is concerned with determining the moral status of nature or larger natural contexts (ecosystems). The plausible justification of an ethics of nature poses some difficult -problems: after all, it is not a matter of an individual ethics of the protection of certain individual beings related to individual organisms, but of supra-individual entities: for example, the protection of species, perhaps even the protection of evolutionary potentials or processes. In this case, natural ethics is "biocentric" (related to all living beings) or "ecocentric" (related to ecosystems) or even "holistic" (related to all natural objects).

Here, considerations of natural ethics touch on difficult questions of natural philosophy. For example: Does nature as a whole have a moral status? Does the right to protect biotopes rank higher than the right to protect individual organisms and species, so that we may sacrifice -individual organisms or even entire populations for the sake of preserving larger ecosystems? Natural ethics thus asks whether

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every form of life or even complex natural interrelationships - and perhaps even nature as a whole - is of moral value and therefore absolutely worth protecting. Such an ethic (however it may be justified in detail) goes beyond the framework of an environmental ethic that is based solely on the interests of humans, even more so than animal ethics. Instead of being anthropocentric, natural ethics is thus physiocentric.

It is clear that within environmental ethics there had to be a conflict between an 'only' anthropocentric and a physiocentric ethics. How are the respective interests of humans and animals (or plants, biotopes, species, etc.) to be ethically weighted against each other? In which cases should the interests of humans take a back seat to those of other living beings? Environmental ethicists must therefore not only assert their concerns against economic and social interests, but also have to contend with internal disputes about the "right" environmental ethic.

THE THREE LEVELS OF ENVIRONMENTAL ETHICAL REFLECTION

For environmental ethics we have distinguished three areas: resource ethics - animal ethics - nature ethics. This division of labour can also be abolished in the concrete case of application. The demarcations therefore only apply analytically and not categorically (absolutely). Some environmental problems - such as water protection, the establishment of nature parks, large-scale urban planning, etc. - have both resource ethics and animal and nature ethics aspects.

For a systematic approach to environmental ethics, however, it is not only important to distinguish between the three subject areas mentioned (which is largely a consensus among environmental ethicists), but also to distinguish between several levels at which environmental ethics comes into play. Following a suggestion by Konrad Ott (Ott 2000), three such levels can be distinguished from each other:

(1) Philosophical level (ethics)

(2) Political-legal level (laws)

(3) Level of environmental protection (individual cases and measures)

On the one hand, there is a division of labour between these three levels, and on the other hand, they build on each other: public measures in relation to individual cases (environmental management) must be legally secured, and the law, for its part, must be anchored in ethical principles.

1. The philosophical level

At this "high" level, it is a matter of principled justifications: ethical validity claims are made that are supposed to apply universally - i.e. to all members of the ethical discourse community. In the philosophical discourse universe of environmental ethics, the arguments pro or contra certain environmental ethical positions are developed and put up for debate. The participants in this discussion are first of all the academically active ethics experts, the environmental ethicists; then they include all persons who have to make environmentally relevant decisions in their professional context (politicians, lawyers, but also engineers, biotechnologists, etc.); but in a broader framework, all people can participate in the environmental-ethical debate insofar as they have a developed environmental awareness and want to be accountable for their actions towards the environment. For orientation, all non-philosophers among the participants in the environmental-ethical discourse are, of course, dependent on the preliminary work of the ethics experts: from the environmental ethicists they expect well-founded proposals for environmentally sound behaviour and the argumentative resolution of environmental-ethical conflicts.

However, within environmental ethics - as already indicated above - there are controversies among environmental ethicists that have so far made orientation difficult: anthropocentric and physiocentric positions in particular are sometimes sharply opposed to each other. And it is not so easy for the wider public to understand the arguments put forward by philosophers pro and con with regard to the various alternatives. But if already the inner-philosophical debate does not lead to objectively valid results, then an environmental-ethical consultation of the public and especially of decision-makers (politicians, engineers, etc.) is only possible to a limited extent. Ultimately, each person and each society must decide for themselves whether they want to give weight to physiocentric arguments in addition to anthropocentric arguments - and to what extent.

Whether and to what extent animal and nature ethical aspects should play a role in the -behaviour of people and societies must ultimately be decided by each person personally or - at the national and international level - politically. However, to ensure that these decisions are not merely intuitive and more or less unfounded, it is necessary to obtain a well-founded picture of the controversial discussions within professional environmental ethics (see section 3).

2. The political-legal level

At this level, it is a matter of defining collectively binding normative regulations and goals for action (such as "environmental quality goals"). Such a definition already presupposes certain environmental ethical attitudes and preliminary decisions. Environmentally relevant goals and programmes are set, enacted and controlled by politics - governments, parliaments and administrations. The decisive instrument here is the environmental law in force at the time. Environmental law combines ethical ideas and the formation of political will in the form of laws and ordinances that are binding for all citizens. The scope for legal decrees is very wide: for example, guidelines, quotas and standards can be defined in addition to strictly binding laws. The role of environmental ethics advice in this regulatory process can be to weigh up the different claims to collective and individual use of environmental goods (water, soil, air, etc.): To what extent, for example, does an entrepreneur have a right to the free use or pollution of water and air? To what extent can individual rights be restricted in liberal societies for the benefit of the community? To what extent does the right to preserve certain jobs take precedence over society's right to preserve an intact and healthy environment? More generally, how can a consistent environmental policy be harmonised with legitimate economic interests? How can environmental sustainability goals (in raw material consumption, energy supply, etc.) be reconciled with short-term private profit interests?

Environmental ethics, insofar as it wants to be effective outside the academic discussion circles, can thus certainly contribute to advising environmental policy and to awakening and sharpening the environmental awareness of the public by getting involved in the public debate about achieving climate goals, about saving the tropical rainforests and fish stocks in the world's oceans, about ecological justice (in the case of threatened discrimination against social fringe groups or people in the Third World) and much more. Environmental ethicists are particularly called upon when it comes to setting environmental goals, quality standards and reasonableness limits, insofar as this involves the qualitative dimension of environmental policy and legal measures. Especially since without an ethically appropriate determination of the relationship between humans/society and nature, concrete measures to regulate behaviour towards the natural environment cannot be justified in an ethically acceptable way at all.

3. The level of environmental protection

At this level, it is a matter of dealing with individual cases of environmental pollution or destruction or environmental protection with the help of concrete measures. These measures are primarily of a technical nature. Concrete environmental management is in the foreground, which means that the know-how of practical environmental experts (environmental engineers, etc.) is in demand. Although environmental ethics cannot contribute directly to the technical solution of environmental problems, it can ask about the sense of such technical measures and their normative legitimacy, as well as help to weigh up different technical solutions, insofar as the depth of intervention, the costs and the possible undesirable side effects of the various measures are different. The implementation of technical measures does not take place in an ethics-free space: collective and individual legal interests are always affected, especially since such measures can never do justice to all the interests of those affected. Who loses out? Who bears the costs? How sustainable should the effect of a measure be? It is precisely in this weighing up that conflicts can arise between a more anthropocentric and a more physiocentric view. What is really (and primarily) worth protecting here? Human welfare or that of animals and plants, for example?

Furthermore: Is the measure suitable at all if the environmental problem to be tackled is very complex and the success of the measure is uncertain? Technical intervention in complex natural contexts

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(ecosystems) is always carried out with a certain degree of uncertainty as to whether the desired success will be achieved at all or whether undesired (and unforeseen) effects may not predominate. Estimating technological effects is much more difficult in the field than in a closed laboratory. Interventions in nature are always real experiments with nature, even if they serve the purpose of renaturation or the absorption of environmental pollution (e.g. through pollution of the air, water or soil), the consequences of which are sometimes irreversible. There is therefore dissent among environmental ethicists as to the importance of economic and ecological methods in dealing with environmental problems: ecology in particular appears to many environmental ethicists to be a "weak science" with only limited predictive power. The quantitative (monetary) assessability of effects is also frequently criticised: How high should one estimate the "costs" of the extinction of a certain insect species in the Amazon rainforest? Is it even possible to put a figure on something like that?

The question of what exactly the alleged environmental problem actually consists of and how urgent its solution is can also bring environmental ethics considerations to the fore. This question goes beyond purely technical aspects and concerns normative aspects with which environmental ethics is genuinely concerned. What is "good practice" in environmental management anyway? Before one conducts risk analyses, one must normatively clarify what a real risk is (this is a question of risk perception). And before one can carry out a meaningful "cost-benefit analysis", it must be clear which values are involved and what an "intact environment" is worth to us, the society, and what costs we are willing to pay for its preservation. The ranking of the values under discussion must also have been determined beforehand. And according to which normative criteria should one characterise "natural values" at all? Utilitarian according to the benefit to humans? Or rather deontological (referring to an inherent self-worth of nature)? At this point at the latest, those questions of environmental ethics that were already relevant at the higher "philosophical level" come into play again.

Furthermore, the question of what is actually a good environmental protection goal or how the success of a measure can be seen is often neither scientifically nor ethically easy to answer. Some environmental ethicists, who come from the ecosystem idea, think that the balance of nature, its preservation or recovery, should be the main goal of environmental protection and nature conservation. But it is not always clear when we can speak of a stable and balanced ecosystem at all, and where exactly the limits of the resilience of a stable system (such as the global climate or a coral reef) lie. It is also questionable whether the recurring imbalances and instabilities in nature are not desirable in principle, because they promote change and evolution. Is it not perhaps the case that instabilities are the motor of evolution and long-term stable systems tend to be the exceptions in nature?

Conversely, it is important for environmental ethics, for its possible contribution to the solution of concrete environmental problems, to know which scientific and technical possibilities (methods, instruments, etc.) are actually available, on the one hand to be able to measure or otherwise determine the specific nature of a certain environmental problem, and on the other hand to be able to determine the success of an implemented measure. It is of little use if, for example, it is ethically clear that everyone has a right to clean drinking water, but no methods are available to determine the quality of the water and to set limit values for its resilience and to be able to control the actual compliance with these tolerance thresholds in a measurable and effective way. The implementation of normative demands on the part of environmental ethicists thus requires the methods of technical environmental protection. Ethical norms must often first be translated into technically controllable norms (e.g. limit values) in order to gain practical significance. For this reason, there is no small dispute among environmental ethicists as to how far environmental ethics should become scientific. It should be clear, however, that a modern (synthetic) environmental ethics cannot ignore either the findings of scientific ecology or the technological possibilities of practical environmental protection.

As applied ethics, environmental ethics is dependent on the results of the empirical sciences when it comes to formulating realistic demands and perspectives. Although ought cannot be derived from being (as an old philosophical principle goes), because ethical principles fundamentally precede all empiricism (experience) and want to apply universally, the scope of environmental ethics is nevertheless dependent on scientific findings: the question of which natural entities (beings) are to be counted among the "moral agents" or the "moral community" and which are not, for example, cannot be decided only intuitively. Whether, for example, a threadworm has a nervous system and is thus possibly capable of suffering and thus worthy of protection from a pathocentric point of view can only be determined in the course of a biological examination. The question of which factors and to what extent are responsible for the overturning of the world climate (really mainly "anthropogenic" factors?) must first be clarified by a precise analysis of climate change before the real "climate sinners" can be named and held responsible.

But of course, environmental ethics can also point out possible risks and polluters beforehand and demand appropriate investigations and precautionary measures for emissions by insisting on the obligation to maintain favourable living conditions for all people on this earth and also for all other species. To urge caution in the face of an unclear causal situation and to reduce anthropogenic emissions as a precautionary measure may well be an environmental ethical imperative! Nevertheless, environmental policy and environmental law decisions can never be based solely on environmental ethical demands and concerns, but will always require scientific expertise and the possibilities of technical environmental protection to legitimise them.

Environmental ethics is in any case a weighty voice when it comes to determining our relationship and behaviour towards nature. In practical terms, it will have to orientate itself beyond all internal positional struggles to the deas of justice for all beings worthy of protection (however far beyond humans) and ecological sustainability (to preserve the natural heritage over time). The guiding principles of sustainability developed by environmental ethics (especially for resource ethics), the species-appropriate treatment of animals (animal ethics) and the intact natural landscape (nature ethics), apply not only to itself, but should guide human actions towards the environment. Environmental ethics thus forms the basis for all environmental education. On the philosophical level, environmental ethics offers justifications for various areas of environmental action, which are to be implemented individually or collectively by all of us on the political and casuistic (individual case) level. Environmental ethics is and therefore remains an ongoing challenge to modern society by strongly advocating a cautious and ethically sensitive approach to nature.

MAIN APPROACHES OF ENVIRONMENTAL ETHICS

Environmental ethics as a new sub-discipline of philosophy emerged in the early 1970s. Until then, philosophy had questioned human actions solely in relation to humans. Actions towards nature were treated exclusively from an anthropocentric perspective. Such actions are good or not good when it comes to the welfare of humans. Environmental ethics now challenges traditional anthropocentrism. First, environmental ethics questions the moral superiority of humans over members of other species on this earth. And secondly, it explores the possibility of rationally ascribing intrinsic values (values in themselves) to the natural environment. Let us first consider the "anthropocentric position":

1. The anthropocentric view

The central ethical question is: Who or what counts as part of the moral universe? In other words, to whom or what do we have direct moral obligations? Who or what has a dignity that must be respected? There can be very different answers to this question.

A moral theory can be considered anthropocentric if it is confined within the boundaries of the human universe and excludes everything that is non-human in nature from direct moral care. From an ecologically expanded ("physiocentric") perspective that also includes non-human beings in the moral universe, this anthropocentric standpoint can appear as a "species egoism" or even as a form of "human chauvinism".

The anthropocentric position is now of particular ethical interest insofar as it includes not only the living people of the present, but also those of the future: in other words, it includes the question of "generational justice". Indeed, the chances of future generations to have a good life are considerably reduced by the damage we are doing to nature today. If moral respect consists in respecting the right to a good life for all human beings, then it must also include the good life of future generations. It is hard to imagine what valid argument could be made against this. However, it is not necessarily clear what the future will look like and what future generations will need for a good life. Although in terms of the future we cannot know exactly the personal and culturally specific possibilities for a good life, we can say something about what future generations are also likely to consider necessary for a good life: For, at least assuming their continued existence, future generations will also claim exactly the same moral rights as present generations, including the right to live. Therefore, an anthropocentric ethics can with good reason demand from us today the obligation to respect the environment for the sake of human well-being and prosperity in the present and the future. In any case, it is obvious that the actions we take today will have a great impact on the well-being of future generations. Thus, we are required to reflect on the extent of pollutant emissions, the depletion of natural resources, climate change and population growth, and to correct our behaviour accordingly.

In the anthropocentric view, animals, plants, ecosystems and all of nature only have a "value" in relation to humans and their interests. Mostly, the value they possess is called "instrumental value". From this perspective, the most important consequence with regard to environmental protection and nature conservation is: the only acceptable reason to conserve and cultivate nature is that the satisfaction of basic human needs - such as nourishing the body and maintaining health - depends on nature. Nature (especially with regard to the finite nature of natural resources) is a precondition for our biological, economic and social life; without an intact nature, human life is not possible in the long run. In an anthropocentric view, air, water, minerals, animals, plants, etc. are necessary and valuable for humans - but only valuable in this sense. There is no other reason to morally value nature as such, since it has no value in itself, but only in relation to human interests. Restraint in the consumption of natural resources (such as animals, fossil fuels, minerals, etc.) can also only be justified in relation to the needs and interests of present or, at most, future generations.

In this view, we do not really need a special environmental ethics, since all ethics is always human ethics. Values are always both generated by humans and related to humans In principle, only humans have a "moral status" and can be considered as "moral agents". In accordance with this very strict anthropocentric view, we must of course distinguish between "direct duties" towards all beings with moral status on the one hand (humans) and "indirect duties" in relation to all other entities (animals, plants, etc.) on the other. From an -anthropocentric point of view, nature is ethically valuable at most in an indirect way if and only if it contributes to the satisfaction of human needs and interests. Thus, when we speak of a "value of nature", we ascribe value to nature only in relation to our own interests in nature. Independent of humans, there would be no 'natural' values at all.

This strict anthropocentric view, however, is in sharp contrast to many people's intuitive feelings towards nature: they value and love nature (natural beings such as plants and animals, or even landscapes, mountains and seas) for its own sake, not only because of instrumental motives, but also for aesthetic and spiritual reasons. Moderate (moderate) anthropocentric philosophers therefore concede that we can harbour more than instrumental interests towards the environment and nature: they argue that it is not necessary for anthropocentric reasoning to emphasise only the pragmatic and utilitarian aspects of our interactions with nature. Without abandoning the anthropocentric position, we can enter into contact with nature in an aesthetic or contemplative (even meditative) way: but then more passively than actively, enjoying rather than using natural resources in a technical sense.

2. The non-anthropocentric view

In this section, we will turn our attention to the possibilities of rationally attributing intrinsic moral values to the natural environment (or its entities). The term "intrinsic value" refers to the fact that nature, or at least certain natural beings (such as animals), have an intrinsic value that we cannot dispose of as we see fit, so that we must treat their beings with respect. Each of the existing non-anthropocentric approaches develops its own central argument for why the "moral community" should be extended to include certain non-human beings.

The non-anthropocentric side of environmental ethics can take very different forms. Only the four most important approaches of non-anthropocentric theories will be discussed here:

1. Pathocentrism
2. Biocentrism
3. Ecocentrism
4. Holism

Each of these theoretical approaches is concerned with the question of which elements of nature or the environment are candidates for moral status and what the argument is for conferring moral status on them. The arguments put forward are often of the kind we have already encountered in the treatment of the main ethical theories. Each type of theory has its proponents. Some of the most important are briefly presented in the overview below.

(a) The pathocentric position

This position assumes that it is morally wrong to inflict suffering on sentient animals. For not only humans can feel pleasure or pain, but animals are also capable of doing so. Animals are thus, in a sense, on an equal footing with humans. Utilitarians like the Australian philosopher Peter Singer argue that the experience of pleasure or the satisfaction of interests as such have intrinsic value, not the beings involved themselves. On the other hand, non-sentient objects such as plants, rivers, mountains and landscapes are not of intrinsic value, but at best of instrumental value for the satisfaction of sentient beings. Ultimately, utilitarian considerations lead to the conclusion that an action that causes harm to individual animals can be ethically right insofar as the interests of another living being outweigh those of the animal concerned.

Tom Regan (1983) has instead put forward a deontologically motivated ethical argument. He argues that some animals have intrinsic value, which he calls "inherent value". These animals have the moral right to be treated with respect. They should not be treated merely as a means to another end. Only those animals that lead subject-like lives have intrinsic value. For Regan, subjectivity is a sufficient (though not necessary) condition for them to have intrinsic value; to live subjectively means, among other things, to have beliefs, desires, motives, a memory, an awareness of the future and a psychic identity that endures over time, in addition to sensory perceptions.

(b) The biocentric theory

Some ethicists have proposed an expanded approach to individual well-being and the intrinsic value of natural entities, arguing that all organisms have intrinsic value insofar as they strive to achieve the best for themselves regardless of whether or not these organisms have consciousness. This position can be called "biocentrism".

Unlike egalitarian and deontological biocentrism, Robin Attfield (1987) advocates a hierarchical view that while all beings that have intrinsic value in themselves have intrinsic value, some of them (e.g. human persons) have intrinsic value to a greater degree. Attfield thus advocates a particular form of philosophical consequentialism that takes into account and attempts to balance the numerous (and possibly contradictory) utility values ("goods") of various living things.

(c) The ecocentric theory

According to Wouter Achterberg, ecocentrism means that natural beings should have the freedom to develop well or to live free from human interference. Ecocentrism recognises the moral status of humans and all other organisms. Moreover, nature also deserves our moral respect at higher levels than that of individual organisms, e.g. at the level of species and ecosystems.

(d) The holistic theory

According to Wouter Achterberg, there are two possible ways to extend our moral care to collective entities, e.g. ecosystems: One of them assumes cognitive adaptation processes: We need to change our perception of the value of complex natural entities (entities) to include even simple organisms such as bacteria. An example of this ecocentric approach is Aldo Leopold's "land ethics". According to Achterberg, Leopold's considerations aim at an ethical holism: the ecosystem (land) as a whole is accorded a moral status. In essence, this says:

- the "land" (as a metaphor for nature, so to speak) is a community of interdependent elements;
- the land as an ecological community and its components themselves must be treated with moral respect; and
- the land as such possesses an (intrinsic) value that reaches far beyond its economic and instrumental value for us humans - a value in the philosophical sense: this means something like "intrinsic value".

Leopold's central thesis is expressed in the sentence: "Examine each question (of land use, WA) in terms of what is ethically and aesthetically right, as well as what is economically expedient. A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise". Leopold uses two metaphors here: The land as a (social) community and the land as a living organism. The first metaphor emphasises the relative independence of the elements of the ecosystem and their moral status. The second underlines the given systemic "cohesion" of the ecosystem.

In this context, Wouter Achterberg distinguishes between three types of holism to clarify Aldo Leopold's position: metaphysical, methodological and ethical holism. Metaphysical holism considers the "whole" to be as real as its parts. Methodological holism states that in order to understand the whole (e.g.

the ecosystem), it is not enough to consider the parts that make it up separately. Finally, according to ethical holism, some of these "wholes" must -deserve our moral respect because they have a moral status (just as some companies have a legal status, regardless of the legal status of the individual shareholders). Ethical holism therefore does not need metaphysical and methodological holism as a basis.

The passage through the various anthropocentric and non-anthropocentric approaches should, of course, only provide a very brief overview. Even if one is content with a biocentrically expanded anthropocentric environmental ethic, which includes not only humans but also all sentient animals, it should have become clear that nature, at least in part, also has an intrinsic value that must be taken into account in human interventions in the natural balance or in ecosystems: nature is not only the origin and basis of life for all of us, but also a living tissue that is worth preserving as such. It is a moral imperative to at least show consideration for the well-being of animals. And this includes not only species-appropriate animal husbandry in agriculture but also all biotechnological (genetic) interventions in the animal organism as well as, for example, animal experiments for medical purposes.

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