

NOTES AND DISCUSSION

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CURRENT PROBLEMS

OF THE BIOSPHERE

Ecology shows that living beings, with all their diversity, make up a homogenous system on the earth's surface, with rules that are no less exacting than those applicable to gravitational astronomy (celestial mechanics). The physical energy coming from the sun in the form of radiation is attracted by green plant-life, be it vegetation growing on the land or microscopic algae floating on the surface of the ocean; this energy is then transformed into chemical energy, with, incidentally, a modest yield, due to the process of chlorophyllian synthesis. This stage is the only one to include a productive process—an anabolism. Other sorts of living beings derive their energy and the elements necessary for their sustenance and multiplication from organic matter devised in this way. Some vegetarian animals feed on them and are in their turn prey to predators which are themselves devoured by other predators. Food chains, grouped in bunches or network systems, are thus established on the principle of a complex pyramid. Each consumer occupies a place at a trophic level, which is clearly defined, where he guarantees the conveyance of matter and energy which are degraded in accordance with the laws of thermodynamics. These biological mechanisms entail numerous species, ranging from the most elementary forms of life to birds and mammals. Decomposition agents then recycle the mineral elements and make them available

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to plants. In any given area, the inert chemical elements and the community of living beings (embracing all species) together constitute a biological entity or *ecosystem*; this is a kind of supra-specific organism which functions with a certain flexibility, and yet is ordered down to the last detail. Just as a man consists of a heart, lungs, a liver, so a natural community consists of "organs" which are each made up of one of the various constituent species. These ecosystems are the fundamental units of the living world and they are relatively independent of one another, although exchanges do occur between them. They all come together to form a balanced system which encompasses the whole complex of living beings. This is the biosphere, a gigantic mechanism with innumerable cogs and gears which have evolved in harmony with each other throughout the whole of history, going as far back as the first trace of life on earth.

The biosphere, or just nature if you prefer, constitutes an entity which, at first glance, is independent from man, and was elaborated well before he appeared. It is not less true that man had the task of integrating himself within the biosphere, and at some point plugging himself in to the circuits so as to obtain from them his means of subsistence; and that he was part of the biosphere from his earliest beginnings. From the outset he exercised his particular influence over the biosphere, just as any animal you care to name might. At first he lived as a predator and pillager, by hunting, fishing and gathering (fruit etc.). But the thing that instantly singled him out from other animals was his ability to light a fire. By setting fire to the scrub at the right time of year in order to hunt or better adapt the environment to his needs, early man, who still held the key to no more than a rudimentary kind of technology, was in a position to modify the biological balances on a large scale and drive back the woodlands to create open savannah-like country, which, still today, houses small isolated tribes which have remained at a primitive level of life. Fire is a force which has a powerful action on nature and in those very early times whole sections of our planet were already affected by it.

It did not take long before these means of subsistence were clearly inadequate and above all ill-suited to the life-style of man as he became increasingly gregarious, numerous and keen to move on from his nomadic way of life. As a result he started

to tame certain natural ecosystems and then create artificial ones by replacing wild species with various carefully selected domestic animals and plant species. In a forest or savannah, natural productivity is often very high; but only a sometimes tiny fraction can be used by man. The transformation of the various environments and the creation of fields and artificial pasturelands considerably increased the proportion of productivity which could be consumed directly, and made it far easier to gather and harvest the various crops. The agricultural and land revolution of the Neolithic Age marks the decisive turning point in the history of mankind and man's relationship with the living world about him. From that moment onwards the satisfaction of his justifiable needs called for a mood of violence towards nature and, in addition, the radical transformation of certain types of habitat. This latter development invariably culminated in a simplification of the ecosystems: man replaced the numerous species which made up a community by a single, cultivated plant species, or, at the most, a handful of species, or a few carefully selected types of grasses which served as fodder for his domestic animals. The food chains became considerably reduced and the energy circulating within the system became tightly channeled, which is the basic condition for a high energy yield. The primary biological distinction between animals and man resides in this sort of manipulation of the various ecosystems.

These practices, which are the very basis of agriculture, frequently ended in the establishment of stable artificial ecosystems in which the soil had even acquired a greater fertility than it had boasted in its original state. But the influence of man also had speedy negative effects. Some of man's acts of interference, dating right back, can be considered as so many ecological mistakes, at odds with the elementary laws of the biosphere. Thus it is that, since Antiquity, the Mediterranean region has been ravaged by poor farming methods and land use, and even Plato is found deploring the fact that "in comparison to what it used to be, the earth is like the skeleton of a body which has been emaciated by disease." The same applies to tropical regions, too, specifically in Africa and Central America, where the collapse of the Mayan civilisation was, at least to some extent, due to poor land management and the fact that they turned a blind eye to conservation practices.

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The transformation of habitats and the cultivation of land are in fact only possible in areas where the land has quite specific pedological, climatic and biotic characteristics which define the agricultural use for which it is suited. In those zones which are known as marginal, these practices quickly set in motion processes of rapid erosion and often destroy habitats and soils beyond all hope of repair. This, unfortunately, was what happened once man left the particularly favourable regions. The transformation of Brie (the district bordering on Champagne) and Beauce into rich agricultural land was a success, whereas the transformation of the great central plains in the United States into monocultural areas was a failure. The ecological, physical and biotic conditions are not the same in both countries. And in one case the conversion was made slowly and progressively, while in the other it was imposed extremely abruptly and constituted a violent interference.

This sort of upheaval has become more frequent and far-reaching in modern times thanks to the increase in the world population as a whole, technical progress and the soaring standard of living of at least a section of the human race, requiring more and more and as a result bringing greater and greater pressure to bear on the biosphere. In fact, although the factors in question have remained the same, the phase we are currently witnessing is without precedent in the whole history of man. And this applies to its very essence, because of a total change in the scale of the operation in time, space, and in the potential of the means being employed.

However, even if the biological factors are enough in themselves to explain the progressive deterioration of the state of things throughout human history and the speeding-up of this tendency until we have arrived at the present critical point in time, the way in which men have carried on has always contained an element of determinism which goes beyond strict biological motivations. It is thus advisable, first and foremost, to look for the roots of the problems of the day in the actual make-up of our own psychology.

Man's relationship with nature has, from time immemorial, been marked by a blatant hostility on his part. It is true that certain oriental philosophies require a respect for life in all its forms, because man is considered as a metaphysical part of an

overall complex in which he is just one among many constituent elements. Western thought, on the other hand, which has moulded our industrial civilisation, stresses man's undisputed supremacy over the rest of the living world. Man is no longer *part of* nature: he is *in opposition* to nature. Seen in this light he is better placed to dominate and take control of nature, given that he is fundamentally separate from it. Our philosophers, be they spiritualistic or materialistic, have done little to bolster the maintenance of a certain equilibrium between man and his biological environment, with the exception perhaps of Spinoza and the German movement known as *Naturphilosophie*. It thus comes as no surprise that the technological civilisation which has ensued has culminated in the dogma of profitability, and that it has not succumbed to an ethic which is in alignment with our potential, to use Robert Hainard's term.

Psycho-analysis, perhaps, throws an even brighter light on certain aspects of the way man treats nature. Do we not, after all, persist in displaying instinctive and unreasoned aggressiveness towards nature? And yet we should have freed ourselves from certain complexes which affected our far-distant ancestors who lived in the thick of nature and had to defend themselves against it every minute of the day. Everything was against them, dangerous animals, parasites ruining their crops, plants and weeds invading their fields. And even today, in the tropics, the farmer is forced to wage a continual battle against the natural elements. A moment of negligence and trees start to sprout from sawn-off stumps, and the scrub will elbow cultivated plants from their fields. Wild herbivorous animals come and feed on crops before they are ready to be harvested, and carnivores take their toll of livestock, large and small, the moment the farmer's fences (and defenses) are down. And one need hardly mention the pest that comes in the form of insects which bite and sting, leeches, parasites and all those others which carry innumerable diseases. The forest is also a refuge for evil spirits, which emerge from it to persecute the living.

Perhaps we still tend to try to protect ourselves today from this encroaching, hostile image of nature, which was a reality in the days when wolves made the journey from Paris to Saint Germain a risky undertaking, and which caused men to die of hunger from famine as they dreamed of rain and wind. But this

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tendency is the issue of an atavistic instinct which is quite pointless nowadays. We carry on as if we wanted to erase all trace of that past and have our revenge on the last traces of the prehuman biosphere by acts which hail, purely and simply, from vandalism, and even sadism.

Even when our behaviour does not reach these limits, we still, consciously or otherwise, admit to the fact that our civilized world is to be built on top of the ruins of the natural world. Now that we have brought our technological knowhow to an advanced stage, we believe that we can henceforth do without nature and nature's products. Our mastery of a wide range of scientific disciplines has little by little given us the notion of creating an artificial world. Physics and chemistry have opened up vast and triumphant perspectives which were inconceivable just a few years ago. In the field of agriculture the "Green Revolution" has given rise to man's wildest hopes and made it possible to think in terms of putting an end to food shortages by a clever combination of farming methods, chemical fertilizers, pesticides and high-yield varieties of crops and vegetables. In addition the advances scored in the field of medicine offer us immunity from numerous diseases and have resulted in longer life expectancy.

It thus seems that we are in control of all our problems, and that we have the resources to find solutions to new ones as they arise by applying new technical methods which emerge as our scientific knowledge continues to broaden at a stunning rate. To the man in the street it now seems that anything and everything is possible, for the man in the street is at once wonder-struck by and prey to the propaganda put out by those who enthusiastically back the technocratic system. Emancipated from nature, which he has replaced with his own technology, man has simply to conform to the essential laws which govern the way in which the biosphere functions. And the biosphere has been replaced by an anthroposphere, or, better still, by a technosphere born of our own genius, whose task is at once to form the frame of our existence and to give us our means of subsistence, and happiness. In a word, we are tending to replace a Jovian order by a Promethean order.

This triumphant attitude puts the industrialized countries in an embarrassing situation when they try to persuade the devel-

oping countries to avoid the mistakes already made by the technological culture and respect the vital requirements of an equilibrium which is better adapted to their climate, their types of soil and their vegetation. You Europeans and Americans only became great and modern powers when you had finally exterminated your bison, your carnivores and your large birds of prey—in the words of some envoys from tropical countries, you urge us to protect our elephant, our tiger and our buffalo, living evidence of a primitive state bordering on those barbarian days, in order to keep us in an inferior position and in order to block the road to real civilization, as represented by the great city, the factory and the neat, square field—in other words pollution and intoxication by the misuse of pesticides and chemical fertilizers.

In dealing with this line of thought, ecologists over the past decade have shown that in a large proportion of the African savannah, which is subject to torrential rain and terrifying drought in quick succession, and whose vegetation may be reduced to next to nothing for many months of the year, the yield in terms of animal proteins is far higher when the numbers of large wild mammals (elephant, buffalo, antelope etc.) are kept at a high count, than when they are replaced by domestic animals. In East Africa the biomass—the live weight in other words—of the large herbivorous mammals reaches 39 tons per square kilometre, whereas the same areas support between 3.5 and 5.5 tons, no more, of domestic livestock per surface unit. The wild animals use the vegetation to better advantage, and each species occupies a specific alimentary rung on the ladder without competing with the other species sharing its habitat. On the contrary, bovine animals graze selectively, and pass by a lot of plant species within the various vegetable associations. Replacing a whole fauna by a single animal is nothing short of ecological nonsense. Whence the idea of directly exploiting wild herbivores in order to provide better nourishment for peoples suffering from deficiencies in animal proteins. In spite of various problems, which have as yet remained unsolved, to do with the conservation and transportation of carcasses, man is pursuing an economy based on land clearance, the establishment of waterholes, enclosure, preventive and curative medicine, and the enrichment of pastureland, all of which are costly investments for up-and-coming African states in the current economic circumstances. And delicate soils are pro-

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tected, because the transformation of environments often endangers their ability to resist the factors which bring about soil degradation.

This policy has proved itself. And yet it did not receive the applause that it deserved. In the Neolithic Age man perfected a "recipe" by inventing the domestication of certain favoured animals. He lived off this acquired knowledge, once he had colonized every corner of the world with cattle, sheep and goats of various kinds, which were ill-suited to many types of climate and many types of environment. The power of prejudice and routine is such that it prevents man from evolving and innovating in his use of natural resources.

The reasons for the rejection of new solutions undoubtedly go even deeper. Wild animals belong to nobody. One cannot count wild animals as one can domestic cattle. One cannot boast about one's head of cattle, which is all important in communities made up of pastoral people where wealth is measured by the size of a herd and where all important transactions—such as marriages and negotiations with supernatural powers—are carried out with cattle, sheep and goats. Man experiences a feeling of frustration if he is not master of his means of production and subsistence, if he depends on a natural system rather than on a system created by himself and designed for him alone. We are face to face, in this respect, with the eternal and weighty conceptual conflict between integration within a biosphere which remains beyond our reach and integration within an artificial system which is created and controlled by ourselves.

By deliberate choice we find a situation in which our contemporaries revel and to which many other peoples, who have not yet reached our level of technology, aspire. Bacon and Descartes dreamed of it in their day. Once he has come of age man must "master and possess nature." Deep within him he is spurred on by a sense of practical anthropocentrism, to use Gabriel Marcel's expression. The increasingly astounding conquests of science and technology—the daughter of mother science—appear to back him up and confirm his own supremacy and the validity of the products of his genius. A contemplative philosophy has been totally replaced by a philosophy of action, whereas the healthy outcome would have been a happy symbiosis of the two, as suggested way back by some of those ancient Greek thinkers.

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The idea of systematically condemning everything that man did in order to guarantee the means of subsistence necessary for the survival of his species and his own betterment is far from our minds. As is the idea of advocating a return to the pastoral state in which man would live by gathering fruit and hunting wild animals. Because of his vast numbers, his vast requirements and his highly developed technology, man will only ever be able to exist in a state of comparative violence towards nature. Mankind is closely reliant on artificial ecosystems. The irreversible and vital phenomenon of industrialisation will always entail, as a corollary, the production of waste, hence various types of pollution which will contaminate the air, the oceans and rivers, and the land. The city in some form or other is an integral part of modern man.

It is quite as legitimate to fight the natural pests and scourges to which we are still victim. By creating the field, we have brought about an imbalance and in the same breath encouraged the proliferation of depredatory insects. We have no choice but to gain control over such pests, and the use of synthetic chemical products will be inevitable. The war against diseases which are carried by insects and harboured by rodents will require the deployment of effective measures, to the point of limiting and even eradicating (in local areas) certain species. Man relies on artificial conditions and he must maintain them at the optimum level. The simple fact is that he will have to employ products which are man-made.

But he does not depend *only* on these conditions, and the maintenance of these optimum conditions does not depend *only* on him. Things that can be undertaken in favourable areas, where the climate, landscape and type of soil make it feasible to establish stable crops which can be farmed intensively and with machinery, are unthinkable in other places. Arable farmland, which accounts for about ten per cent of farmed land, exists on great plains which are subject to major climatic contrasts, in fertile valleys, and on the benchland of mountain ranges where clouds condense. If there are still a few patches of ground to be put to the plough, the idea of doing so in places other than the above is wishful thinking. Large tracts of land cannot be given

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over to intensive farming without running great risks. The conditions are unsuitable in such places for any type of intensive planning, quite simply because the land itself is fragile and liable to be irremediably degraded at the slightest interference. And yet we go on stubbornly applying the same "recipe" across the earth's surface, under a wide variety of pretexts. We are keen to improve our lot, to satisfy the justifiable needs of handicapped peoples, to nourish and feed those who are hungry and would like to enjoy some of the benefits of this technological civilisation, whose rumble has been heard as far as the deepest bush and outback, carried there by a few newspapers or the strains of a transistor radio. Just as unfortunate is the fact that new resources are often exploited to the advantage of a few countries which are already well provided for, and for the supplementary benefit of categories of people who are already surrounded by a surplus.

The main arena for such practices at the present time is the intertropical zone. The countries here are under-developed, and face tricky economic and demographic situations. The soil in these countries is delicate and the ecosystems are hard to deal with, in spite of an apparent wealth of growth which is so often illusory beneath the lush cloak of the forests. Once these are stripped of their original flora, erosion sets to work in no mean fashion, even though a few satisfactory harvests to start with bolster the convictions of those in support of the plan, justify their crowing bulletins and their statistics, which in turn reassure the banker, the economist and the politician, not forgetting the poor native who thinks all his troubles are at an end. The exhausted soil is soon unable to yield any more than a subsistence economy based on lean crops and raising emaciated livestock. The degradation of the environment reduces to nil the efforts and the investments made. The natural capital will waste away and the poor will end up even poorer. The fault will lie with the elements, the fact that there has been too much or too little rain... rest assured, a scapegoat will be found. And the scapegoat will never be the men who decided what had to be done under the pressure of economic or political requirements. Attempts will be made in other places, using the same methods, to set up the same operations which failed through lack of foresight.

These ecological dead-ends are becoming more and more commonplace throughout the world. What is called development

is, in a healthy number of cases, nothing short of irreversible devastation, serving only to meet the immediate needs of a human race which is too numerous or to quench the thirst for profit of a handful of people.

The most endangered environment of all is the humid tropical forest. The stocks of wood in these forests are coveted to the extent of being plundered in the most shameless way imaginable. At the present time there is a serious shortage of pulp and new methods are making it possible to use hitherto unusable tropical woods. In addition to this, and predominantly, people are keen to replace the humid forests of the tropics with land fit for crops and grazing—once again by using artificial systems. Gross errors with grave consequences are currently being made as a result of man's failure to grasp the real ecological position. One tends to forget that when dense forests are effectively managed and not simply clear-felled they are in themselves a source of wealth, they protect the soil and absorb the high rate of precipitation in the tropics, and in addition offer an astonishingly stable environment by their very diversity and as a result of the interaction of their innumerable constituent elements. One likewise forgets that they play a vital rôle on a planetary scale by intervening in the elemental cycle and in the balance essential to climate and water. In other respects, and in spite of their unrivalled lush growth, their countless flora and their highly diversified fauna, the humid forests of the tropics are on the whole poor. It is rare to find mineral elements in them; the high level of biological productivity is primarily the result of a swift process of recycling of the elements and of the extremely intense metabolism of a system which only entails a relatively low amount of matter. After a few growth cycles, the rains, the sun and the uncontrolled vegetation will have reduced the seemingly fertile elements to nothing.

Up until the Tertiary, Amazonia had stood up to all the many ups and downs it was subjected to. Now it is about to be criss-crossed with roads, used to the hilt for its wood, and man will transform vast tracts into grazing and cultivated land. In some places the soil will tolerate this type of farming, but elsewhere the earth is poor and has been leached for a long time. The abundant precipitation and the incredible growth rate will soon do away with the last minerals. What will then remain of this

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luxuriant mantle? Ecologists are well aware of the fact that the dense forests of the tropics can only survive if their surface area exceeds a certain point. If it falls below this point, the skirt of the forest starts to be gnawed away by the process of savannisation. This is a natural phenomenon which happens to accelerate man's relentless drive towards the very heart of the massif. What has already taken place in the region of Manaus or Iquitos does not exactly make the future look any rosier. Amazonia is the great economic and political hope of modern Brazil, but is there not the risk that it will one day be the sorry counterpart to the south-east zone of the country? There, too, a forest was destroyed out of thoughtlessness, in order to grow coffee. Erosion took a quick hold on the soil which was left at the mercy of the atmosphere, against which the coffee-trees and shrubs could afford no protection at all. The coffee "front" advanced towards the west, leaving in its wake a country in ruins, reduced to a subsistence economy.

The position as far as the great forested massifs in Africa are concerned is no more encouraging. In a matter of years 74% of the forest has been razed to the ground in Nigeria. The vast massifs in the Ivory Coast are little more than a blurred memory, and the Congolese massifs are already being gravely damaged. It will be Gabon's turn next. The railway running across Gabon will link Libreville with Belinga and Franceville in a few years time. It will also open the way to mining vast deposits of iron ore and manganese, and hewing down the forest. An initial stretch of track ending at Booué will open up some 3,000,000 hectares (7.5 million acres approx.) for mining and other development, and other areas more to the east. People who have seen the primeval forests of Makokou and Belinga, by the biological station of the *Centre National de la Recherche Scientifique*, which has received so many scientists through its doors, cannot help feeling apprehensive. The issue is certainly not one of stopping Gabon from building its economic prosperity on its mineral resources. It is rather the fact that a stable environment will be replaced by artificial forests and crops with uncertain futures that fills those observing such operations with concern. Those who do not believe in the Trans-Gabonese railway, somebody once said, are the same people who did not believe in the motor-car seventy years back. Might one not also say that those who believe in the

agricultural advantages of this railway are also those who, not so long ago, believed in the coffee plantations in Brazil's "terra rossa," in the development plans for the Orient, for the Andean countries, the Nyari, the Congo, Séfa, Casamance and the Tanzanian ground-nut scheme which was one of the most dismal of all post-war failures?

Deforestation of this type is even more serious in hilly areas. The fact is that man continues his systematic stripping of mountain regions in Latin America, Asia and New Guinea alike. The action of streams and run-off is quick to whisk away the thin layer of arable land which has taken thousands of years to form, and is protected by a plant covering which is suited to the environment. All that will remain is the bare rock, and the valleys will be clogged up with deposits which have become non-productive. The act of clearing forests and setting fire to the brush on hillsides and mountain-slopes where tens of feet of rain fall annually—sometimes as much as three feet a day—is nothing less than genocide. The transformation of a damp tropical forest into pasturelands has never ended in anything other than failure. And yet this practice, which is called development, carries on with the blessing and backing of national and international organizations whose aim is to assist the Third World.

The situation is no better in the dry tropical savannah. For the last two years public opinion throughout the world has been stirred by the tragic consequences of the drought that has ravaged the Sahelian-Sudanese savannah which stretches from Senegal to the Red Sea. There is little point in reminding ourselves of the losses suffered by the shepherds whose flocks have diminished by 60% and sometimes even more, or of the socio-economic consequences which include the surge of people back towards the south, usually towards the cities where they end up in refugee camps or shanty-towns. The drought is undoubtedly due to a natural process caused by wholesale climatic anomalies, which have recurred more than once in the course of recorded history. But man managed to worsen the consequences by the now traditional effects of over-grazing, which was first of all encouraged by the old colonial powers, and then by international and charitable organisations, which are as generous as they are ill-informed about the ins and outs of ecology. What is the point of sinking wells and vaccinating cattle when the limiting factor is the amount

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of fodder available in the fields?

All the way from Senegal to the Sudanese coast the desert lurks near at hand. Its advance is a geological phenomenon which proceeds, even without human interference, like a slow death-agonny, 4000 years old. Springs are drying up, as are rivers, and the vegetation slowly retreats, taking with it men and animals alike. But man is in a position to slow down or speed up the natural phenomenon by the way in which he manages the soil and pasture. The machinery that drives the infernal cycles has been dismantled in the arid regions in north-west India, which has a delicate climatic balance, but was in former times the seat of prosperous civilizations; and formerly too it was far more humid, a fact which has been demonstrated by paleobotanical analysis. The atmosphere in this area has a water-vapour content equivalent to that of the damp tropical forests, and yet rain rarely falls and is poorly distributed throughout the year. This state of affairs can be explained by the density of dust hanging in the air which has been ripped by the wind from land which has been subjected to intense over-grazing. The more man reduced the wealth of vegetation by letting his flocks roam freely through it, the less it rained because of the alteration in the atmospheric conditions and the drop in condensation at the level of the flora. The sedentary farmer gradually gave way to the nomadic shepherd, and a relatively humid type of savannah yielded to the desert. The same relentless chain of events brought the African savannah to its present state by speeding up a lethal natural process. Economies of this sort are ecological dead-ends, the final stages of evolutionary processes which embrace far more prosperous phases. It is tragic that they confirm Reifenberg when he says that the nomad is not the son of the desert, but rather its father. These false deserts have an annoying tendency to spread through regions with delicate climatic balances which man thinks he can use as he pleases, from Senegal to Ethiopia, and from Arabia to India.

Careless use of the soil is especially evident in the tropics, but not peculiar to them. The temperate zones fall prey to it as well, as is shown by the changes being currently undergone by the countryside throughout Europe. The rural landscape, which is without any doubt the work of man's hand, has been slowly moulded down the ages by generations whose history, sociology

and way-of-life are all contained in it. It represents an ecological balance which has evolved down the centuries in terms of topography, climate and soil make-up. We are in the throes of brutally destroying it by hewing down trees and hedgerows, levelling off slopes, damming up rivers, and generally reducing it to something monotonous and ugly. Already in the west of France there have been upheavals at the water-board. The drying-up phenomenon is more accentuated in summer in agricultural regions which have undergone modifications as a result of intermediate environments being suppressed. On the other hand, there is more rain than there used to be, and the rain violently swells the rivers. The recent floods in Brittany are undoubtedly connected with abundant precipitation; the consequences have been heightened by untimely atmospheric disturbances occurring in slope basins as a result of the re-allocation of the agricultural zones.

The coastal marshlands where different soils rub shoulders and intermix, as do fresh and salt water, are currently being systematically destroyed as ports, factories, urban complexes and tourist resorts spring up. And yet these ecosystems are among the most productive in terms of organic matter which finds its way onto both the land and the continental shelf, and forms the basis of rich food chains. By their being driven back, the biological potential is inevitably affected.

Not even the sea is safe from encroachments which entail grave consequences, and which can already be observed in inland drainage basins. The Baltic is partly sterilized by the pollutants pouring into it from its shores, by insecticides, by salt from heavy metals and salt produced by plastics. The Mediterranean is already awash with vast amounts of waste, and would be close to catastrophe if all the plans for drilling for oil which are now on the drawing-board, were given the go-ahead. Oil would be extracted at a depth of more than 2000 metres. If anything went wrong, or if the pumping systems broke, a huge geyser of fuel oil would burst loose from the sea-bed and cover the whole surface with hundreds of millions of tons of oil. The Torrey Canyon disaster would be like some incidental news item compared with this potential black tide which would turn the French, Spanish and Italian coasts into evil-smelling mire.

In the North Sea, surrounded as it is by heavily industrialized countries, and subject as it is to intensive drilling operations,

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the numbers of fish are dwindling under the combined effects of constant over-fishing, spawning-grounds being disturbed, and harmful industrial pollution which affects eggs and larvae. In the North Atlantic, systematic surveys carried out between 1948 and 1969 show that the plankton count has consistently dropped, that the plankton's appearance in the spring months comes later and later and that its period of plenty is growing briefer and briefer. It is quite legitimate to think that this phenomenon, possibly associated with spontaneous fluctuations in the physical environment, is also brought about by the residue from the light hydrocarbons burnt by aircraft and scattered along the world's most frequented air routes.

Any day now our technical knowledge will enable us to go straight to the depths of the oceanic environment which has, to date, been beyond the reach of our industrial organisations. We shall be tempted to alter the balance of the natural ecosystems within which we still exercise no more than an influence similar to that of Paleolithic man, but on a slightly different scale. We are running the grave risk of causing serious disturbances in them, possibly even damaging mechanisms as basic as oxygen and carbon cycles.

Faced with such threats, international law seems to be singularly defenseless. Nations have made efforts to join forces by drawing up agreements which have been and are limited in scope and poorly observed. They are jealous of prerogatives which have been valid since the day of the sail-boat, outstripped nowadays by giant oil-tankers, and as a result refuse to allow the high seas the benefits of the rule of *res communis* and refuse to abolish that of *res nullius*. In this field, as in many others, we have neither the ethics nor the jurisdiction to measure up to our potential.

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Nature thus comes under attack from all sides. It is true that we do not have any formal proof of any worldwide deterioration of the conditions required for the maintenance of life on earth, such as the overthrow of fundamental biological cycles, or any alteration of the upper atmosphere which might upset the thermic equilibrium of the planet. We should beware of writing

science-fiction and we should also beware of forecasting an ecological apocalypse. The situation as it stands is sufficiently serious without going to such extremes, and biologists are now unanimously agreed on this reality.

Pollution of any kind is an indisputable pest against which war must be waged. For centuries economists have been leaning on the notion that the "nature" factor is provided for man free of charge. It is high time to review the concept of external economies, and admit that from now on we shall have to pay to have pure air and pure water. In most instances the cost is very high. It is up to us to decide whether or not to pay the price and whether it is too high for society. If we decide not to, then we must abandon all activities which entail harmful effects, even if their immediate benefits appear to justify them. Some technological choices which have to all appearances already been made must also be re-evaluated. The question is not to do with halting progress, which would be inadmissible intellectually, technically and politically, but to reorient progress and direct it qualitatively on the basis of rational aspirations for the future and the obvious unsuitability of many present-day solutions.

The progressive and accelerated degradation of biological systems which we can measure by means of clearly defined parameters, is far more serious than the effects of pollution. It is the result of a whole series of ecological errors, but above all of an inadequate evaluation of what the biosphere still represents for man, and it is to this degradation that we should turn our minds first and foremost, in order to remedy the process. Chemistry and physics have equipped us with fantastic means of action in the form of powerful machinery and tools and considerable sources of energy. Agronomy, stock farming and forestry have reached a conspicuously high level of development. Pleased as punch with ourselves about these skills, we have used them to transform the world. According to the apostles of the technological era, once we have mechanized, high-yield farming, domestic animals which have turned into nothing less than factories for converting primary production into animal proteins with hormone shots and synthetic foodstuffs, and when in the very near future we have other marvels such as the pickings of marine farming and the alimentary use of synthetic proteins or hydrocarbon derivatives, we can consider that natural systems

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of production with a lower immediate yield are out of date.

One can never over-stress the fact that there are environments which we cannot touch without setting in motion processes of degradation on a world-wide scale. Perhaps one day our knowledge will enable such areas to be tackled, when our biologists have explained their basic mechanisms to us in detail. This is yet another reason for preserving them in their rightful state and not jeopardizing sources of future biological wealth by premature action.

Of course, a certain level of awareness tends to stimulate us to review our policy. Under the aegis of UNESCO, the International Biological Program has tried to make an exact assessment of the productivity of different environments and define the rules which would govern a better use of some of them. On a scientific level the results are positive ones, and ecology has advanced in leaps and bounds thanks to this coordinated international effort. The practical consequences, on the other hand, are sadly mediocre. Will the program "Man and the Biosphere" (MAB) really have a more far-reaching effect on those in charge, politically speaking? One would dearly hope so, because its aim is, specifically, to redefine, within the current context, the relationship between man and the biological systems on which he depends. And during all this the renewable resources are being exhausted at an alarming rate. Their volume cannot be maintained at its present level except by using up the capital that we have mixed up with the revenue in the wake of those 18th century physiocrats and more than a few contemporary economists. They will collapse when there is nothing left to clear or reclaim, when the planet has turned into rubble-strewn deserts and laterite shells. Our ecological knowledge makes it possible for us to forecast the bankruptcy of the present system of farming and land-use, which will persist only as long as is necessary to destroy what remains of nature. With the technical means we have at our beck and call, a few decades may be all that is needed.

How out of date it is to believe in the exhaustible wealth of the earth! This ancient myth, which found its second wind in the era of major discoveries when Europeans found their way into virgin regions little altered by the sparse aboriginal tribes with their limited technologies, has been kept in trim by numerous economists since Ricardo whose work, *Principles of Political*

Economy, mentions the “undying and indestructible powers” of nature. Such statements now strike us as being extremely inaccurate.

A no less disastrous wastage occurs as a result of poor management of space, especially in the densely populated industrialized countries. In spite of countless plans and schemes, industrial and other establishments are still being set up in a completely anarchic and disorderly way. On the one hand the towns and cities continue to push their way outwards until even the word gigantic becomes inadequate; on the other the policy of decentralization multiplies the foci from which the degradation of traditional landscapes fans out, and entails the creation of communication networks which devour the land and generate erosion. Ranging from the construction of mammoth airports on our finest agricultural land to the strip-building of second homes and pleasure resorts on our coastal dunes and beaches, all our activities tend to impoverish the space available to us, and bring about wastage in terms of the biological potential of the planet, not to mention the accelerated destruction of a whole series of highly productive ecosystems and the ruin of picturesque habitats which are vital to ecological equilibrium on a world-wide scale.

Other types of squandering can be attributed to the quickening consumption of our energy supplies. The recent energy crisis, treated as a mere news item brought about by a set of political circumstances, has merely had the effect of making a process which has been foreseeable for ages more brutal and abrupt. Our energy supplies, especially the fossil fuels, are drying up, whereas our demands are increasing in an exponential way. Industrial energy consumption has, on the average, quadrupled in fifty years; it will double in the next twenty. Because primary energy is used less and less directly and transformed as a preliminary into electricity, the production of the latter doubles every ten years, which corresponds to a 100% increase during a man's lifespan. In company with Robert Gibrat, one may well ask how long this rhythm can be maintained without thoughtlessly exhausting our resources, even if we call on the atom to come to our aid. And nuclear energy, with all its grounds for hope, is also a hazardous solution, even if we do not attach too much importance to the rantings of a few alarmists.

The increased consumption of energy has easily foreseeable

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consequences for the process of industrialization as a whole. Is it commonly known that, with the way things are at present, there is six times more electrical plant in operation than all the machinery that has been scrapped since the beginning of time? This implies an industrial effort which is racing onwards at a crazy pace. The increase in energy requirements reduces resources, but it also carries the economy away with it, and at the same time multiplies the volume of pollution and renders it beyond our control for both technical and financial reasons.

The exponential growth of our needs in terms of renewable or mineral resources, water, space and energy, is a worrying fact. The principle of continuous expansion is in itself absurd from the moment that it relies on taking large slices out of our finite resources. The Club of Rome, among others, has already clearly underlined this. Unfortunately, expansion satisfies our way of thinking as much as it pleases both "bosses" and "workers," by providing a short-term solution to the problems of the day, including the need for jobs. This flight forward, which is now obsolete, is already a guilty factor, because it is no longer synonymous with progress. Far from excluding evolution and the re-organization of the distribution of natural resources, and the distribution of the revenue of a worldwide capital to be administered in optimum conditions, stabilization or controlled growth is favourable to these things.

Man is suddenly realizing that the world in which he lives, this planet of ours which is like a space-craft in which the biosphere is the means of survival, is contained within narrowly defined limits. We cannot draw exponential curves in a finite envelope. We have not yet reached these limits, which are like constants, but in many respects we are not far from them. Optimists will rejoice, and pessimists will consider that the stay of execution will be put to best advantage by doing nothing. Our lack of concern may induce us once more to postpone the decisions called for by a situation long since analysed by the ecologists, and a situation now beginning to be differently interpreted by economists. It is time to stop squandering, and, as has been wittily said, time to replace the cow-boy economy by a cosmonaut economy. Man's flight into space has enabled him to flee this earth and at the same time realize that he is a prisoner of mother earth, as well as her co-owner and co-admini-

strator, in the words of Raymond Latarget.

Then again, nature is not only a source of material supply for man alone. Untamed nature, and the nature which man has gradually altered down the centuries with a respect for its beauty, are vital components of man's happy state, and vital also for his moral and psychological equilibrium, and even his physiology. It is impossible to calculate their material values in figures and make them part of an economic balance-sheet. They have enabled great civilizations to flourish and brought about their ruin once they stopped being taken into account. It is up to us to bypass the caricatural deviations of all those who neglect beauty, culture and science and reason only in terms of profit.

Our future and our basic interests are at stake. Once again we are on the point of sacrificing the long-term advantages. And delaying decisions which we shall inevitably have to make one day in the heat of the moment, and under a pressure of events which will bar any loophole. The time for making a calm choice is coming to an end. We must make sure that the time does not run out. Seen in this light, all the current discussion about certain concepts of liberalism and socialism seem totally out of their depth in the context of the evolution of the industrial societies and those societies which still have not reached this stage. The stake is elsewhere, and school debates are as futile as the Byzantine cavilling which heralded the fall of the Empire. The difference this time is that the Empire is our planet, surrounded by interstellar or outer space, and no longer just a limited slice of the earth, with reserves lying all about it, and hence a thorough chance for civilisation and mankind to survive.

The biologist may point out the facts, give them a material interpretation and put us on the alert. But what he proposes will be to no avail whatsoever if it does not influence the positions assumed by man on a higher plane. It is good to analyse the consequences of our actions, but such analysis comes to nothing if it does not result in our reviewing our philosophy of action, which has been the philosophy of the west for centuries. It is only when this happens that the decision-makers will start acting in the clearly understood interests of mankind.