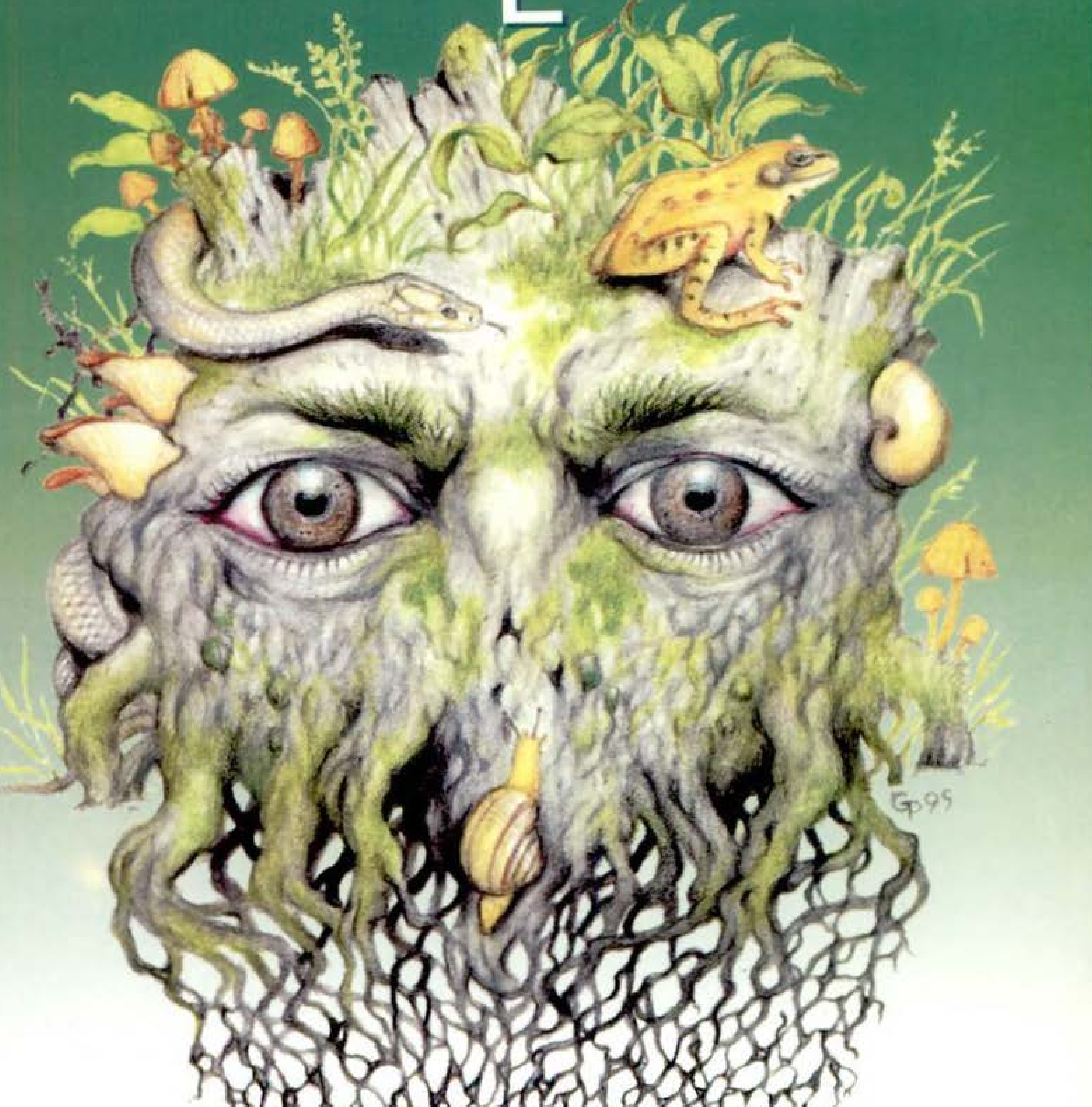
Valentin A.
Krassilov

Ecosystem and Egosystem Evolution



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I. INTRODUCTION

The young Mary Shelley prophesied that science would create a monster that would forever breach it from society. In the XX century, this Cassandra prophecy seems to have come true. A scientific approach to man, mankind and nature has led to a huge bloody attempt to reshape all by which this century will be memorable. Disparity between science and humanistic aspects of culture has reached the point whence scientific would mean inhumane.

But is the disparity inevitable? Or is it a lamentable consequence of a mistake once made and stubbornly stuck to for a long time but still amendable? As a Russian saying goes, half-learned is worse than ignorant.

Since the earliest times, people have been looking for a definition of their existential goals in the context of natural laws. They have been trying to locate man in the chain of living beings which seems to constitute a gradual succession from the humble to the lofty. Evolutionary ideas have been inspired by this succession which has been then fortified by parallel successions of the geological record and individual development. These parallelisms seem to convey a universal law, i.e. the line of thought which can lead to a really general system theory as the foundation of the evolutionary theory aiming at a definition of the human existential goals.

But what first appears as wisdom often ends in banality. (Thus the symbolic travels of children in search of their parents derived from solar mythology have descended from the Biblical wayward sons down to the countless sentimental screen stories). In the so-called synthetic theory of evolution (STE) which never sought a synthesis but rather strove for an evolutionary theory reduced to a single model of population dynamics, parallelism is often mentioned as evidence of similar selection pressures. But all that is significant about it and all what the evolutionary theory is for was set aside as irrelevant. In effect, the STE has contributed to the understanding of the human existential goals only that there are no such goals whatever. By this it has succeeded in widening the gap between natural science and humanitarian philosophy.

This book is an attempt of a concise synthesis in which evolution is presented as a goal-oriented process triggered by cosmic forces and led through a series of crises to a non-competitive coexistance at a minimal sustainable population density, to a creative life, and to biospheric ethics. Human goals can be found in respect to this general systemic trend. Ecosystem is considered as a principal unit of evolution guiding the historical development of its members, hence the ecosystem theory of evolution (ETE). Its main ideas have been sketched in the late 1960's and in the 1970's (Krassilov, 1969, 1977) when the STE was almost unanimously accepted as the only reasonable framework for an evolutionary synthesis. Since then ecosystem has become a popular word, and some associated ideas have found their way in the modern evolutionary thinking. However, it was necessary to revise most of the basic concepts, such as adaptation, fitness, specialization, etc. Moreover, the ETE strives for a broader and humanistically orientated synthesis for which there is no room in the STE. It opens the way to complementary studies of natural ecosystems and the human ego as a system, or egosystem, based on common principles.

Synthesis is a system sustaining the development of evolutionary research. It is here supposed to be a system of causal links tightening up a number of additive explanatory models each dealing with a single aspect but together expounding evolution as an integral process. *Model* is a conceptual presentation of a system in whatever form. *System* is a set of objects sustaining a certain process. *System goals* are predictable final states defined by the physical laws. Some of the relevant models expounded in my earlier works are here redescribed in a hopefully readable form, with special terminology and references reduced to a bare minimum.

II. SYNTHESES AND CONSEQUENCES

The ancient world was possessed by the idea of wholeness then synonymous to holiness. This idea seems to have instigated the recurrent attempts at creating a universal empire. It inspired the great synthesizers from Epicures to Lucretius. It culminated with Gnostics and then gave birth both to the Christian religion and natural science.

PREHISTORIC HOLISM

Io, loved by Zeus, was turned by him into a cow to escape from the jealousy of Hera. She was driven first to the north, then to the south and west, and on the banks of the Nile she gave birth to Epaphus who became the forefather both of the Egyptians and Greeks and, through Perseus, also of the Persians. On her way the cow encountered Prometheus who foretold her future, namely, that she would run until stop. This most absurd part of the story which even Aeschylus could not make plausible, might suggest the original version had been ruthlessly edited. Not Zeus but Prometheus was believed by the Ionian autochthons to have been the creator of the humans (and his brother, Epimetheus, of the animals). Thus the original meaning of

Prometheus' encounter with Io could probably be that she bore by him, so that people descended from titans and cows (in comparison, the Younger Edda version claims that a cow turned salty stones into people by licking them). Io in her wanderings followed the Sun, a life-giving titan.

While we are used to fairy-tales disguised as history, the ancient myths are history-disguised as fairy-tales. Cadmus followed a cow until he came to the land where he fought a serpent, stirred an intertribal combat between the serpent people and founded the city of Thebes. In his old age he himself turned into a serpent. This is a fairly precise history of the Arian cow-herdsmen invading the land of Semitic serpent worshippers, constantly involved in their intertribal wars. As a rule, the conquerors adopted a more sophisticated religious system of the conquered.

The Io story is a similarly precise though highly symbolic presentation of the history of life on earth, stirred by the Sun and moulded by titanic natural forces while advancing from animals to humans.

Prehistoric cow-herdsmen felt themselves in unity with nature. For those natural people, nature was human. Their gods were conceived of as parts of a cosmic human-like body as they were depicted in the most ancient theological work, such as the Texts of Pyramids (Firchow, 1953). However, by the time when the Io story acquired the shape we know, ancient holism had gone to pieces (and it seemed no longer plausible that we had descended from a cow covered by a titan), although it took a Herculean effort to destroy it.

LABOURS OF HERCULES

As a baby Hercules killed two serpents and, in the service of Eurystheus, the king of Argos, he proceeded to kill or capture various animals, such as dogs, horses, bulls, boars and lions. These were heroic deeds, because the exterminated animals could be dangerous, if not physically then spiritually. They were the most powerful totems fought off by the new (Argivian) creed spreading from Argos. He also cleansed the stables of Augeas, a metaphor of a totemistic culture, for Augeas was the Sun's son, and his cows were the sacred sun-cows.

Hercules, an extremely unbalanced person subject to hysterical feats, serving the hysterical king of Argos, endeavoured to severe evolutionary links between man and nature, thus shaking the balance between the natural and cultural foundations of human existence. And he eventually succeeded. The labours turned our ancestors into the deeply cleaved creatures in a permanent search of wholeness.

WHOLENESS

If there is an inconsistency in a story as perfect as the Scriptures, one is justified in suspecting that something important must have been omitted from it in the course of subsequent editing. In the case of Jesus Christ born of a virgin the whole philosophy behind that birth had been omitted. In essence, all creatures are dual: they combine the ever conflicting male and female heredities. To achieve wholeness, one of the sexes, preferably the male, has to be excluded from conception.

But such a conception must be divine because this world consists of conflicting opposites the unity of which is achievable in the opposite, eternal, world.

It was said that the last would be the first. Sounding like a demagogic egalitarian slogan when out of context, this was just one from a long list of the opposites. Not only the last will be the first, but also the inner side will be like the outer side, and man and woman will be like one (Testament by Thomas) as light and darkness, right and left, life and death (Testament by Phillip). Gnostics have revealed what was kept undercurrent in the canonic gospels: the tragedy of the lost wholeness (whole, holy, hal, hail are of the same root) which they ascribed to some initial mistake.

But it was not a casual mistake but rather a Herculean labour that breached the cords between man and the Universe rendering human existence tragic.

Primaeval people felt themselves equal to the Universe and there were no bounds to their magic wills other than the wills of other beings - humans, animals, things and gods, the latter conceived of either as helpers or adversaries in the magic performances.

Children recapitulating the spiritual history of mankind, show rudiments of this primordial *Weltanschauung* which Schopenhauer vainly tried to revive in his "Die Welt als Wille und Vorstellung."

Odysseus, coming safely to a harbour, said quite casually that some friendly god - a nameless helper - might have shown the way. Yet the Homerian Greeks were already not so confident in their magic wills. They had lost the naive determinism of prehistoric people subordinating themselves to the blindly indiscriminate universal will, randomness itself, blind Fate (as their oriental cousins did to karma) - a philosophy of disappointment and surrender. This tragic existential philosophy made them heroes, pathetic figures who suffered gracefully and killed without mercy, unmitigated even by chin touching, an ancient appeasing gesture (see the decapitation of Dolon in the 10th song of the Iliad).

It is a common misconception, started with Heraclitus, that Homer made no moral judgements. His great poem accounts a collapse of the ancient moral system which was conveyed not so in words as in symbolic gestures (e.g., touching the adversary's chin) in part perhaps inherited from animals.

At about the same time Moses, a Jewish hero, saw his God from behind. He belonged to a different culture in which all earthly wills were focused in a single universal will, not random but purposeful, to which the people were not mere victims but servants. They saw the meaning of their life in servitude, although the universal will had more and more distanced itself from material life. Actually Moses was the last of the ancient breed capable of a direct communication with the metaphysical world. His successors were very strict in separating the creator from the creation, and they were ever watchful of any reference to the former in the material world. Thus, Jesus was prosecuted upon the charge of idolizing himself.

Their oriental and occidental contemporaries were more indulgent in granting the mortals a possibility to attain wholeness, or perfection, to become Buddha, if not in practice then at least in theory. They sought harmony of the inner world in perception of the eternal world beyond. As Plato wrote in "Timaios", we have "to observe harmony of the cosmic orbits to repair orbits in our heads disturbed at birth; in other words, we have to restore the initial affinities of the observer with the observed and by this to attain the perfect existence as a goal set by gods for the present and future times".

CHRISTIAN SCIENCE SYNTHESIS

Christianity synthesized the above ideas as the cognitive foundation of Christian science which sought harmony in nature - expressed in natural laws - to set a model for human existence. A lot of natural laws, including the Mendelian ones, have been discovered upon this line of research.

Since the ancient Greek times adaptedness of all living beings has been seen as a manifestation of universal harmony. Plato attributed to Protogoras a theory by which Epimetheus, the creator of the animals, endowed each species with special means of survival so that none of them would be threatened by extinction.

However, as harmony arose from the primaeval chaos, so the modern species could be the only survivors of the multitudes of, for the most part maladapted, primaeval creatures. These selectionist ideas were expounded by Lucretius who ascribed their origin to Empedocles.

In the Christian time, adaptedness was conventionally accepted as an essential intrinsic property of all living beings. The idea of an archetype and modifications caused by environmental factors was shared by Linné, Buffon and other leading botanists and zoologists. It was championed by Goethe in his *Urpflanze* theory which, until recently, served as a foundation of plant morphology.

Another manifestation of harmony was the continuity of all beings, from mollusks to man or even from stones to man, with fossils as intermediaries. The idea of continuity had started with Aristotle but it was given full swing by Leibniz who linked it with evolution (though considered as unwinding of some predestined patterns - *prästabilierten Harmonie* - rather than the origin of any novelties) and, particularly, with a progressive development of mankind.

The latter implication of Christian perfectibilism inspired Turgo, Condorcet, Erasmus Darwin and other philosophers (but was ridiculed by Voltaire in Candide, with Leibniz as Panglossus).

The time famous disputes between Cuvier and Geoffroy Saint-Hilaire or Cuvier and Lamarck revolved around Leibniz's theories. Cuvier stood for a revolutionary development of the organic world stirred by environmental calamities, while Lamarck was able to combine the ideas of adaptedness, continuity and progress in what was the first scientific evolutionary synthesis.

Further developments were due to a rapid progress in palaeontology showing a general trend from the morphologically simple organisms to the increasingly advanced ones in full agreement with the Christian perfectibilism principle. Moreover, a new science of embryology discovered a very similar though highly condensed succession of embryonic stages.

These exciting observations pointed to a certain patternizing force responsible for a "triple parallelism" of the morphological succession in the present time plane, the fossil succession through geological times and the sequence of developmental events through embryonic stages (Agassiz, 1848). This parallelism was taken as evidence of a general principle at the roots of all biological phenomena.

These ideas paved the way to the general system theory and a unification of natural sciences. But they were pushed aside by the rapidly advancing Darwinian paradigm.

THE DARWINIAN SYNTHESIS

The "Origin of Species" could be seen as a synthesis in the sense that it accumulated evidence of evolution drawn from various disciplines. However, the ideas which laid down the foundation of the evolutionary thinking have been largely ignored. This was partly due to the Briticized positivistic education of the time but there were also other reasons, both general and personal, of which the former ones went back to Galileo who had attempted to emancipate natural science from theology (a sin for which - though the official charges had been totally irrelevant - he was prosecuted by Inquisition perpetually nudged by his scholastic colleagues). In his time it was a progressive endeavour which, however, made for an ever widening gap between the positive natural science and humanitarian natural philosophy.

There were a few heroic minds who ventured to bridge the gap, and perhaps the most prominent among them was Erasmus Darwin, a physician and poet who made important discoveries and inventions in astronomy, geology, botany, physiology and technology (to call him a Renaissance man would flatter Renaissance for there were very few such universals those days). In his time he became a target of parody and ridicule involving the then famous but now forgotten George Cunning and William Paley. The latter even spoke of "Darwinism" meaning empty speculation.

Charles Darwin mentioned his grandfather only once and that in passing, but the nightmare of "Darwinism" was obviously lurking in his mind through all his creative years. A fear of darwinization forced him to postpone the publication of the "Origin" while seeking the patronage by Lyell and Hooker. He focused on natural selection as a "secondary" cause (a subsidiary to the "primary" - providential - cause briefly mentioned in the epilogue (Darwin, 1872) as a tribute to the Christian paradigm), totally within the competence of a respectable man of science. He saw species as an arbitrarily chosen variety (and what is the origin of species then?). He refused to deal with "Lamarckian" progress. He vigorously rejected natural catastrophes - another French vice, counterbalanced, in the judicial Victorian spirit, by Lyell's theory of imperfection of the fossil record (giving a false appearance of abrupt changes when actually there were gaps in the sequence of strata).

Darwin went as far as to state that he who denied imperfection of the fossil record might reject evolution ("my theory") as well. In this he posed as a paradigmatic Popperian scientist who, when erecting a theory, is prompt in gracefully showing the way in which it can be falsified. However, while Darwin was a proponent of inductive science and while the only hard evidence of evolution might have come from the fossil record, the imperfection claim, casting a grave doubt on fossil evidence, came short of denying the factual basis of the theory.

HERACLITEANS

It may seem wonderful that, despite all the opposition and ridicule, the Darwinian theory came through so rapidly. The not yet shaken faith in science and Darwin's respectability as a scientist may have played some role, but more essential factors lurked behind the scene.

It was hardly accidental that modern art was born at about the same time. In 1863, Edouard Manet painted his "Olympia" which, when exhibited in the Salon in 1865, caused a scandal. Notably, among the many abuses, the nude was called a "female gorilla" (ironically, Manet's model Victorine Meurend in her middle age was seen with a performing monkey).

It is well-known that Manet just copied Raphael in his "Picnic" and Titian in "Olympia" (like Charles Darwin followed in the footsteps of Francis Bacon). What was then so modern and, for some contemporaries, so odious in his painting? Had they not seen a nude before? They might have, but those traditional nudes had been set forth as examples of what was beautiful while Olympia, whatever the intention of the painter might have been, had nothing exemplary and even nothing permanent about her. She belonged in the Heraclitean world of perpetual change, not in the Platonic world of immutable essences. Her appearance, as well as the appearance of the "Origin of Species" three years earlier, signalled a turning point from the long prevailing Platonic to the for a long time shadowy Heraclitean world view.

Neither Darwin nor Manet seems to have realized the wholesale impact of their works on European existential philosophy. But they both sensed the turning point and, as modernists under a traditionalist disguise, contributed to the new developments. For the early Darwinians it was perhaps a pure intellectual game, in the same way as for the Impressionists it was just a game of colours. The tragic aspects of living in a world in flux surfaced in the next generation.

THE POST-DARWINIAN SYNTHESIS

Though the post-Darwinian theory is known as synthetic (referring to a conceptual unification of genetics and classical organismic disciplines), it was neither a synthesis of Darwinism with any of the rivalling evolutionary theories nor even an enrichment by any new concepts. On the contrary, all the rivalling views, including those which Darwin saw as viable alternatives, have been successfully "refuted" (Mayr, 1993), that is, pushed away from the limelight by cutting them off from the leading journals and educational programmes, while the remaining ideas have been reformulated in a more categorical language.

Thus, if Darwin considered some heritable changes occasional, the post-Darwinian "synthetic" theory of evolution (STE) claimed all of them stochastic. While Darwin accepted the inheritance of acquired characters, but remained doubtful about its evolutionary importance, for the STE these were nonexistent, and so on. Later all or most of the STE dogmas proved false, but for many years they were publicized as triumphs of new biology.

The STE was so oblivious of the original Darwinian ideas that, when revived, they were sometimes opposed as anti-Darwinian. Just this has happened in the case of the punctuated equilibrium (Eldredge & Gould, 1972) and neutral polymorphism (Kimura, 1968; King & Jukes, 1969) models. Yet both models were anticipated by Darwin.

Perhaps the most important developments stemmed from the axiom of nonheritability of acquired characters. While it rendered all acquired in the course of life unimportant for evolution, the focus of evolutionary research shifted from the organism to a population of gene carriers. For natural science this meant that such organismic disciplines as morphology, embryology, physiology, palaeontology and others prospering in the XIX - early XX centuries would decline, and they did. By putting emphasis almost exclusively on microevolution, the STE has diverted biological and palaeontological research from macroevolutionary processes. It was assumed that, millions of years granted, microevolution would give macroevolutionary results, though there was scarcely any evidence backing that assumption.

Applied to humans, the population-oriented ideology has meant that individuals are far less important than classes or races and are easy to sacrifice for the sake of the latter. Thus the consequences have spread far beyond the area of biological research.

ETHICAL IMPLICATIONS

Reactions to the Darwinian theory were far more emotional than to any other scientific speculation at least since Copernicus. The XIX century Europeans seemed reluctant to have savages as their direct ancestors or apes as their cousins. Yet evolution had been much talked over long before Darwin, arising mockery at worst, while Linné had assigned humans, apes and monkeys to one and the same division of his classification system, and got away with it. What was wrong with monkeys was that they had never figured among totemic animals of the western Arian tribes. Had it been a horse or a cow, the whole story might have been taken easier. But only the very naive could take the monkey issue in earnest. A far more serious issue - the great myth of Harmony - was at stake.

Universal Harmony, the Pythagorean-Platonic concept, was the cornerstone of a Christian world view. Natural man had to be as harmonious as Nature itself. And it was by observation of the cosmic Harmony that he could repair his spiritual harmony disturbed by a primordial mistake or sin.

Charles Darwin seems to have done with natural harmony once and for all by putting a merciless struggle for existence in its place. Man as a product of natural selection had to be hard, cruel, competitive and altogether unscrupulous by nature. Moreover, while evolution depended on random heritable variation there was no way for improving the human nature other than waiting for a favourable variation - a theory which left very little room for Christian perfectibilism.

Darwin has revived the tragic Homerian world of Randomness, blind Fate. The long forgotten Manichaean creed resounded in his teaching. Though perhaps unaware of affinities, he succeeded to Schopenhauer's pessimistic view of nature and society as "der Krieg aller gegen alle", i.e. "the war of all against all". Schopenhauer believed in evolution by a stepwise "*Überwaltigung*" of lower stages by higher ones (he died in 1860, a year after the advent of the "Origin" which he did not approve of, finding it too shallow).

Darwin was influenced by Malthus who had cast some doubt on a harmonious natural design, suggesting that a considerable part of the human population was excessive. Patrick Matthew, who claimed priority over Darwin, had advanced his natural selection theory in a paper on forestry (1831), a patriotic writing in the "rule Britain" spirit, being most explicit on the subject. As some letters show, Darwin himself was fully aware of the political implications of his theory, e.g., in the case of the massacre in Tasmania.

At the same time Darwin was much more influential than his predecessors for he had all the authority of Science at his back. For many Darwinism was an embodiment of modern science itself. Even British humanitarians who had old traditions of holding science up to mockery, were inspired with owe. G. Bernard Shaw wrote in the "Three Plays by Brieux" how he "had been caught by the great wave of scientific enthusiasm which was then passing over Europe as a result of the discovery of Natural Selection by Darwin, and of the blow it dealt to the vulgar Bible worship and redemption mongering which had hitherto passed among us for religion. I wanted to get at the facts. I was prepared for the facts being unflattering: had I not already faced the fact that instead of being fallen angel I was the first cousin to a monkey?"

Others were less enthusiastic. George Meredith wrote in his "Egoist" that tales were all that science could give us. Unawares Darwinism put an end to the pre-Raphaelite movement while fostering the Aesthetic movement and the art for art's sake doctrine.

English literature amply illustrates the changing attitude to science and scientists. While Frankenstein was a noble if too zealous a character, his post-Darwinian successors were depicted as ruthless and cunning criminals. It was not in vain that Arthur Conan Doyle mentioned Darwin in his Sherlock Holmes stories. In addition to Professor Moriarty who hold in his bloody hands all the strings of the criminal underworld, there were the murderous Stapleton, naturalist, the villainous Professor Coram, the grim Dr. Sterndale, a famous explorer of Africa, and other equally dangerous scientific figures. Science became habitually associated with crime.

But the reaction at home was mild in comparison with that on the continent where the "Origin" inspired both Marx and Nietzsche as well as, in the lower quarters, the Nihilist movement (first brought to light in 1862 by Turgenev who coined the name), involving medical students who occasionally committed crimes indicating natural selection as a motive.

Bourget developed one such case into a novel in which a series of tragic deaths followed from a too ardent application of biological methods to soul and spirit. Daudet, Flaubert and Dostoevsky wrote in the same vein while Tolstoy probed the depths of the problem in his great novel "Anna Karenina". His conclusion was that the scientific theories of the origin of man as an animal had nothing to do with the significance of life and death. "Mind has discovered the struggle for existence and the law upon which I have to strangle anyone interfering with my wishes. This is a conclusion of the mind. Whereas love to other beings could not be discovered by a rational mind for it is irrational".

Russian culture was rich in humanistic traditions, but it was no more than a thin film over the fathomless clandestine spiritual life of the millions of illiterate people. The Russian cultural elite was apprehensive of the dangers issuing from the moral implications of the Darwinian theory, and the appearance of the great Russian literature of the 1860's might have been instigated by these apprehensions.

Tolstoy probably did not know that Darwin placed altruism outside the tenets of natural selection. But, justified or not, anti-intellectualism of Russian intellectuals had the same effect of paving the way to the Russian revolution slaughterhouse as nihilism of their opponents who worked from the other end. Russian cultural life was divided between these extremes, and the extremes met.

It followed from the dogma of nonheritability of acquired characters that mankind could not be effectively improved by any means other than selection of the best genotypes. In this way the brave new world could be erected. On the other hand, any slackening of natural selection would allow the accumulation of deleterious mutations resulting in a degenerated mankind.

Leading geneticists of the time estimated that, without eugenic measures, a genetic collapse would inevitably occur, and not later than the early 1950's. These geneticists looked with aspiration to the post-revolutionary Russia as a country in which a comprehensive eugenic programme could be launched. But in the 1930's the Soviet rulers set off another programme of building up a network of concentration camps aiming at an "atonement" of the alien elements. The rulers indulged those people of science who pledged a heritable atonement possible, allowing them to exterminate (or atone) their scientific opponents. A more fertile soil for eugenics was soon found in the Nazi Germany.

Was Darwin responsible for the genocide practices of the brave new world? Was Einstein responsible for the Hiroshima bombing? Perhaps yes, for they triggered off the respective changes of events leading to catastrophes. Could or should they have been more concerned about the moral implications of their theories? Perhaps they should.

ALTERNATIVE

For most evolutionists, the shortcomings of the STE are more or less evident. However they adhere to this theory for, as they believe, there are no viable alternatives. And no wonder, because for many years the STE was at work refuting all possible alternatives. As Mayr (1993: 31) has put it, the STE is "more than a synthesis" for it "included a convincing refutation of the three major antidarwinian paradigms - the typological - saltationist, the teleological - orthogenic and the transformations - Lamarckian".

Yet recent publications in the most advanced fields of biology show that this titanic refutation campaign has failed. The rapidly accumulating evidence for adaptive DNA modifications (hence the inheritance of acquired characters) and saltational loss or acquisition of genetic material (e.g., Landman, 1991; Drake, 1991) makes it no longer possible to stubbornly deny these phenomena and their evolutionary significance, while the "teleological" concept of evolutionary progress has never been seriously shaken.

Even the STE depicted evolution as a telic process aimed at adaptedness, i.e. a capacity of sustaining the populations through a succession of generations. But if adaptedness is a goal, then it must have long been achieved already at the level of blue-green algae surviving for billions of years, in fact much longer than any of the later appearing more sophisticated organisms which they surpassed also in the range of adaptability. What was then the reason of evolving beyond the level of procaryotic unicells?

An alternative theory must answer this and other related, long suspended questions, inevitably touching upon the human existential causes and goals. Thus it would be much broader in scope, providing a framework for many productive ideas pushed away to the periphery of scientific establishment by the now prevailing paradigm. At least some of the stones rejected by the builders may be even reused as the cornerstones of a new construction.

With a change in goals, there will be an adequate change in causation patterns. In short, an alternative theory would deal not only with "how", but also with "why" and "what for".

GOALS

For some years teleology was confused with theology, thus ousted from the realm of science. But there is no need to associate goals with supernatural activities, for any natural system has its goal. They are so intimately connected that to deny goals is to deny systems. Some scientists actually refuse to admit systems, or, as the Russian saying goes, they cannot see forest because of trees. But they are fewer or less influential now than they used to be a few decades ago.

System is here defined as a number of items mutually sustaining an activity of a kind. Suppose there is an activity, or process, such as a chemical reaction involving a number of substances which could react. But in the course of the process there has been a selection of those substances which have certain chemical affinities so that they could sustain the reaction, the rest being ousted from the system. In other words, systems are shaped by the processes which they have to perpetuate.

Systems are most readily conceived of as goal-orientated, or telic if they evolve towards a certain predictable state, such as the state of maximal entropy for closed systems or the state of minimal rates of entropy production for open systems. Living systems are those which reproduce themselves in the process which thus will not be exhausted. Incidentally, the genetic systems have been formed in the process of reproduction and they have the exactitude of reproduction as their goal.

As life on earth evolves, there should be a goal. If we fail to recognize it, it is our fault, not an inherent aimlessness of the system.

Thermodynamics, a discipline studying the macroscopic parameters of equilibrium systems and their behaviour under excitations, emerged contemporaneously with the Darwinian theory of evolution. But while Ludwig Boltsmann was inspired by biological theories in his profound statistical evaluation of the Second Law, as well as in his shallow social philosophy, there had been virtually no feedback until a century later, when Ludwig Bertalanffy (1960 and elsewhere) formulated the general system theory, and Ilya Prigogine (1980 and elsewhere) studied the thermodynamics of open systems. Though their intrusions in the realm of biology were looked at with much suspicion by traditionalists, it became increasingly clear that the living systems were no exception from the principles of thermodynamics and that biological equivalents of thermodynamic functions and potentials, such as entropy or free energy, could be eventually found.

This does not mean that biology would be reduced to physics or copy a physicalist methodology. Quite on the contrary, biology would emancipate itself from the physicalist dictate to which it is liable at the present as a science having but a vague methodology of its own. Using physical laws as a starting point, biology and, for that matter, anthropology, sociology, ethics, etc., would discover the emergent characters of living systems and their specific goals. A new foundation for an evolutionary synthesis would then be lain.

DOWNWARD CAUSATION

Life is organized in hierarchical levels, from molecules to the biosphere, with cells, organisms, populations, species, biotic communities and ecosystems in between. Under the STE paradigm, it became habitual to think of evolution as proceeding from the elementary levels to the inclusive, i.e., starting with genic mutations, the carriers of which are selected at the population level, eventually affecting, in one way or another, all the superimposed levels. The mutations have been conceived of as random or mostly so, while the deterministic processes as directed by selection alone.

However, according to these views, selection is not enough to arrive at a new species for the gene flow has to be breached by some random event, genetic or geographical, or both. Furthermore, the biotic communities are not superorganisms as thought of by some naive ecologists of the pre-STE era. For the STE, they are no more than loosely adjusted aggregates of species which by mere chance have found it possible to coexist in the same area.

Modern physics has undermined our commonsensical deterministic attitudes, but not to the extent of randomness being involved each time when a causal explanation is not readily available. Even in the classical drama it was considered bad taste to draw each act upon the *deus ex machina*. It showed that something was wrong with the plot.

Actually much of indeterminism may dissolve with a different approach, not upward from genes to ecosystems, but downward, from the more complex systems to their subordinate subsystems. In essence, evolution is driven by impulses (e.g., geological, cosmic, or human impacts) which trigger off a restructuring of ecosystems, here defined as functional units of biotic and abiotic matter bound up in the life-sustaining biogeochemical circuits. Ecosystem is the uppermost and, at the same time, the most fundamental level of our analysis, hence the ecosystem theory of evolution.

Ecosystem structure pertains to its goal, i.e., sustainability of the circuit, while the constituent species are each assigned a certain role in the process. For them a restructuring of the respective ecosystem would mean a radical change in their roles involving some experimental behavioural as well as morphological innovations eventually to be learnt by their genetic systems.

This causal chain will be considered link by link in the following chapters.

III. GLOBAL ENVIRONMENTAL CHANGE

It is only quite recently that global environmental change and the possibility of its impact on life have been recognized at all. A few decades ago the prevailing view was that all geological and ecological processes were local both spatially and in their evolutionary importance. Instigated by the recently aroused public concern, the environmental studies are still in their infancy and are liable to oversimplified reductionist approaches, with the models of fuel burning emission warming and chlorfluorocarbon (CFC) emission ozone destruction as examples.

Yet natural science may greatly benefit from the advent of global thinking which has to be a general system thinking as well. The mere fact of incipient international cooperation in the field of nature conservation is of great evolutionary importance in itself, for by this activity humans can be guided to the awareness of their purpose on earth.

Since I have already published a book on this topic (Krassilov, 1992b), I would confine further discussion to a brief overview of the causally linked models which - and I have to stress this for non-specialist readers - are far from being widely accepted at the present. Schematically, global environmental change might have been triggered by cosmic impacts forcing orbital perturbations and/or a rotational acceleration of Earth in turn impelling the concerted tectonic, magnetic and sea-level (eustatic) events with effects on climate and environmental chemistry.

COSMIC FORCING

Earth is not only the life-supporting but also the most dynamic among the planets of its group which includes also Mercury, Venus, Mars and their moons. It has a much stronger magnetic field, a much higher tectonic and volcanic activity than Venus or Mars, both planets of a comparable size. It also rotates faster than these other planets. Could there be any cause and effect relationships? Perhaps yes, because a geomagnetic field originates at the inner core/outer core boundary, and the roots of tectonic-magnetic events lie at the mantle/lithosphere boundary. These boundaries correspond to the major density discontinuities across which there ought to be disparities of rotational acceleration.

George Darwin was one of the major contributors to the Kantian theory of tidal deceleration in the Earth-Moon system. He wrote of planetary evolution alluding to the evolution of life, a tribute to his father. Yet the connection might have been even more close than he suspected.

At the present the rate of tidal deceleration of Earth is less than the calculated 2.5 milliseconds per 100 years pointing to a non-tidal accelerating factor. The direct measurements of the length of the day through geological time based on the growth increments of skeletal organisms are yet insufficient for any definite conclusion to be drawn (see a review in Krassilov, 1985). A few scanning electron microscopic studies of Cretaceous corals carried out by the present author (Krassilov, 1985) suggest the day was then somewhat longer than today.

In principle, acceleration could be caused by the impact of a large celestial body transferring its momentum to Earth. Though the immediate consequences of such an impact could be of no more than a local scale, the effects of differential acceleration imposed on the density heterogeneities in the earth crust and interior might have been of a more far-reaching consequence.

Accepting the Leibniz law of continuity, Maupertuis, a XVIII century French mathematician, speculated that species had been made distinct by cometary impacts exterminating transitional forms. More than two centuries later a conspicuous increase in the iridium content was observed at the Cretaceous/Tertiary boundary marked by a mass extinction of dinosaurs and other terrestrial as well as marine animals. Since iridium in sedimentary rocks is predominantly cosmic in origin, a great impact has been suggested (Alvarez et al., 1980). It has been further speculated that the impact dust cloud might have barred the light causing a catastrophic extinction. Although the latter theory is hardly tenable (because extinction was not momentary even in geological terms, it was selective, but not in favour of the less light-dependent organisms, and there was a strong evidence of large-scale tectonic and climatic events at the boundary), the impact or impacts - for several craters of respective geological age have already been found (e.g., Blum et al., 1993) - might have triggered off a series of catastrophic events by causing rotational and/or orbital perturbations.

At the present the most secure of the cosmic theories is the Milankovitch theory of ice ages. Various amply documented temperature signatures in the deep sea and Antarctic ice records show the obliquity (40.000 years) and precession (19.000 and 23.000 years) cycles which correspond to the glacial-interglacial cycles (see Jourzel et al., 1987). However, before the Ice Age these orbital cyclicities, although evident from the sedimentary record, caused no appreciable continental glaciations. Thus they are not enough by themselves, but could have triggered off the glaciation-deglaciation events through changes in summer insolation rates when the situation became sensitive to this kind of forcing.

I suggest that rotational forcing could have played a similar role of a trigger and pacemaker of geological evolution. One of the most significant geological observations is a regular periodicity of tectonic, eustatic and volcanic events. The longest periods of about 180 m years correspond to revolutions of the Solar system around the centre of the Galaxy ("galactic year"). Their subordinate 30 m year cycles have been related to the "vertical" motions of the Solar system about the Galactic plane (Rampino & Strothers, 1984) bringing it periodically under the gravitational influence of large masses of interstellar matter. Not all hierarchical cycles are yet explained but there is a distinct correlation between earthquakes, volcanism and the rotation rate maxima for the period of instrumental observations (Chepizubov, 1983; Belov, 1986).

THE ROTATIONAL MODEL

While geologists were finding remains of evergreen plants north of the Arctic Circle, glacial deposits in the tropics and marine shells on high mountains, it became increasingly clear the face of Earth had changed. Yet it remained less clear whether it had changed gradually (a British view, influencing Darwin) or intermittently (a French view, advocated by Cuvier and his followers). These matters were still disputed actively in the 1950's, but presently - and this is a great achievement of modern geology with its more precise dating methods - the major tectonic, eustatic, magnetic and climatic events appear clustered at certain time levels, the most distinct of which are the boundaries between the geological eras (such as the Cretaceous/Tertiary) and, in a descending order of distinctness, of the periods, epoches, and ages.

We are still missing a unifying model which would explain the coincidence of these events. The plate tectonics model which seemed so promising in the 1970's could not overcome even the initial difficulty of finding its moving forces. Both the original idea of convection cells in the mantle and the subsequent idea of mantle plumes aroused serious geophysical objections (see, e.g., Runcorn, 1980, for criticism on the part of an early proponent of the theory), and the matter was left suspended. In spite of this and many so far unresolved geological contradictions (Wesson, 1972), the plate tectonics model has been proclaimed firmly established by the believers. Indeed, it may be useful as a temporary convention, but the explanations are to be sought elsewhere.

The ideas of rotational tectonics are by no means new, but they have hitherto been applied mostly to such particular problems as the global fault pattern (Vening-Meinesz, 1947). The patterns of the major fault directions have been shown to correspond to what has to be expected in the outer shell of a despun planet (Melosh, 1977). Incidentally, the low latitude regions are traversed by a series of regularly spaced meridional lineaments which are particularly conspicuous in the Indian Ocean, including such well-known structures as the Maldives, Ninety Ridge, Indira, etc., but they also comprise the east African rifts and the meridional segment of the mid-Atlantic Rise. In the mid-latitudes they turn diagonally forming S-shaped figures.

These structures are transected by transcurrent strike-slip faults which cut them into short laterally displaced segments, the more so the closer they are to the equator.

These and similar observations not mentioned here for the sake of brevity make sense only in the light of rotational dynamics (Krassilov, 1989b). Any rotational perturbations would deform the Globe causing an expansion of the polar regions and a contraction of the low latitude regions or vice versa. The global fault system breaking the lithosphere into numerous plates make it possible for this hard outer shell to conform, as a flexible knight armour, to the rotational distortions of a geoid. Basically, all tectonic processes are such conformable shifts of the armour-plates.

Another source of geological instability arises in connection with a heterogeneous structure of the earth crust and interior consisting of plates (oceanic and continental) and spheres (lithosphere, mantle, core) of different densities. Inasmuch as Earth rotation is variable and the acceleration values are density-dependent, these bodies receive different rotational accelerations, and the tension at their boundaries is resolved in strike-slip or slip-over motions, frictional heating and melting of the boundary layers. At the core/mantle boundary these forces might drive the flow of liquid iron in the outer core generating Earth's magnetic field (for the kinematic dynamo model of the geomagnetic field see Gubbins & Sarson, 1994; these authors, however, maintain a typical agnostic attitude to the driving forces of which their model "takes no account").

At the same time, both rotational overslip and friction at the lithosphere/mantle boundary might cause a magmatic activity of the melted mantle material rising as wedges or "plumes" along the weak zones in the earth crust. These mantle upwellings play a crucial role in the rotational dynamics for they transfer momentum from the interior to the surface thus providing for the congruence of Earth's rotation as an integral system of concentric spheres. They also transfer heat-causing thermal events in the outer shell.

On the surface these events originate a number of characteristic crustal features most naturally accounted for by special rotational models. Rotational tectonics is relevant to the ETE as the only model explaining the global synchroneity of ecological crises.

Transcurrent faults: These faults transect the global lineaments, such as mid-ocean ridges, cutting them into short segments displaced against each other in a broken stick fashion. Transcurrent faults are most prominent in the oceanic crust, but at least some of them continue across the continents. In the rotational model, these faults are related to the rotational velocity gradient from the poles to the equator, causing a lateral displacement of latitudinal zones. Notably, the most prominent displacement occurs in the equatorial zone (Tanner, 1964).

This zone is remarkable also in the recently reported geochemical evidence of a cooler mantle underlying the oceanic crust (Bonatti et al., 1993). This feature superimposed on the zone of the minimal Coriolis force is obviously related to Earth's rotation, although in a way perhaps different from the cold slab sinking model of Bonatti et al. (1993).

Migration of the volcanic activity: In the meridional and submeridional volcanic structures, such as the Pacific coastal ranges and island chains, volcanic activity tends to migrate eastward and equatorward. In the case of the Hawaii, this phenomenon has been explained by a northerly drift of the oceanic plate over a fixed mantle plume (Wilson, 1973). Yet in other chains of different geological ages (such as the Line - Cross Trend Islands, see Winterer, 1976) or situated on different plates, volcanoes are switched on in much the same sequence which corresponds to the Coriolis and Eötvös rotational vectors deflecting any magmatic upwellings both from the mantle and crustal sources.

Linear magnetic anomalies: Differently magnetized stripes of the oceanic floor extending parallel to the mid-oceanic rises are currently conceived of as evidence of sea-floor spreading. Yet spreading, if occurred, could hardly have proceeded in jerks adding a parallel-sided block of new crust each time. The linear anomalies can be more realistically explained by a heat wave propagating from magmatic channels in the mid-oceanic rift zone. The heated rock cooled down in the opposite directions, sequentially acquiring its magnetic signatures. In a thin homogeneous crust these time series of magnetic anomalies are linear for they are bound by contraction faults parallel to the mid-oceanic rift zone.

Mid-oceanic rises and marginal strike-slip zones: Mid-oceanic rises are here interpreted as deep cracks (following the global fault system lineaments) caused by a force couple applied to the margins of oceanic plates. The force couple arises in relation to the differential rotation of an oceanic plate and its bordering continental plates as bodies of different densities brushing against each other along their marginal strike-slip zones. Incidentally, the Pacific Ocean - the world's largest area of a dense oceanic crust - is surrounded by a continuous zone of the right-lateral strike-slip faults (first described and appreciated as evidence of rotational displacement by Benioff, 1954) which seem responsible for such typical marginal features as coastal volcanic ranges, island arcs and trenches.

Marginal features: The marginal strike-slip fault zone of the Pacific Ocean is underlain by a thick astenospheric lense supposedly originated by frictional melting at the roots of deep fault planes. Gaping upwards, these faults are superficially expressed as trenches. These are channeling magmatic upwellings which periodically break through the sedimentary cover, are tectonized by strike-slip pressure and then squeezed out as ophiolitic nappes over the continental margin or adjacent oceanic crust. The piles of nappes cause internal heating and develop into coastal volcanic ranges or, if on an oceanic crust, volcanic island arcs.

These are skeletal schemes here intended to show the prospects of the rotational model to develop into a synthetic theory of geological evolution accounting for most geological features in their systemic interaction.

Sea-level fluctuations: In his theory of biotic change caused by periodic floods, Cuvier may have been influenced by the Biblical story of deluge very similar versions of which had been told in Mesopotamia, Greece and other ancient countries. In those legends, the antediluvian world was much different from the postdiluvian one.

There were several sea-level rises in the Holocene, so the flood legends might well have been grounded in historical events. By the fairly reliable Biblical chronology, Noah's flood happened some 4,400 years ago, at the end of the warm Atlantic period and 292 years before Abraham, who was 100 years old when Sodom and Gomorrah, the Jordan rift valley cities, perished in a catastrophic earthquake, and the valley was subsequently flooded about 400 years after the deluge.

There was a famine in Palestine in the Abraham days forcing him to spend some time in Egypt. About 400 years later his descendants again fled from a famine and settled in Egypt with Joseph. Another 400 years elapsed before they left Egypt plagued by various disasters and crossed the Sinai Desert just on time to escape from the flooding of Suez. They founded a state which prospered in the X century BC but was divided and then invaded by Babylonians about 400 years after Moses. The Jews returned from the Babylonian captivity 400 years BC. These 400-year long periods correspond to the orbital excentricity cycles forcing the eustatic-climatic events with their environmental, demographic, social and political consequences. The Holocene eustatic cycles might have been generated by deglaciation and a subsequent rebound of the continental crust. But, paradoxically, much greater sea-level fluctuations happened in a non-glacial Cretaceous period pointing to a quite different and more general causality.

In the Late Cretaceous epoch, about a half of the total continental crust, 42 m sq. km of the present-day land, was covered by epeiric seas. While their depth did not exceed 500 m, the oceanic rises and plateaux, now at the depths of about 2,700 m, periodically emerged above sea-level. In effect, the total area of the Earth surface at the hypsometric levels of -1 to +1 km might have been twice as large as at the present testifying to a considerable flattening of the global hypsometric curve which was more like that of the Moon than the present-day Earth (Krassilov, 1985).

In other words, the vast expanses of the continental and oceanic crust now isostatically compensated at the hypsometric levels of 0 to 1 and -4 to -6 km must have been closer to each other, which means a lesser centrifugal force. This reasoning brings us back to rotational dynamics, for at a slower rotation the density gradients would be less accentuated by an angular as well centrifugal forcing resulting in a less steep hypsometric slope than at the present. At the same time, the issuing sea-level rise would affect rotation, forming a positive feedback loop, according to the following model.

Rotational-eustatic positive feedback: In the tidal friction model, most of the tidal deceleration occurs on broad, gently sloping shelves (Munk & MacDonald, 1960). Deceleration draws the isostatic compensation levels of the continental and oceanic crust closer together resulting in a flattening Earth hypsometric curve. In effect the total shelf area would be considerably expanded and, therefore, the total tidal friction would increase.

Actually, in the geological history, a sea-level rise has been, as a rule, followed by a series of increasingly higher sea-level rises until the trend becomes abruptly truncated by a supposedly extraterrestrial intervention conferring a rotational acceleration, as discussed above.

CLIMATIC CHANGES

A correlation between sea-level fluctuations and the climate is evident in the geological record, the high sea-level epoches, such as the Late Cretaceous or Early Eocene being the warmest, with no or insignificant polar ice caps. As it has already been mentioned, the deglaciation - sea-level rise loop holds for the Ice Age but not for the previous times. So a different explanation must be sought. Among the models which have been invoked to explain this correlation the following seem significant.

The albedo model: The highest sea-level rises as in the Late Cretaceous could have decreased the total albedo of the Earth surface from 0.33 to 0.21 (Yasamanov, 1991) which is equivalent to an about 5-6°C increase in the average global temperature. This is in agreement with independent estimates of the Cretaceous warming (Krassilov, 1985). Regressions at the end of that period might have reversed the trend, and then a further albedo cooling was brought about by glaciations.

The oceanic heat capacity model: The present-day climate is governed by the enormous thermal inertia of the oceans maintaining permanent temperature contrasts between their surface and continents, a heat machine ever driving the cyclonic whirls that bring rains to the equator and heavy snowfalls to high latitudes. Both tropical rain forest and broad-leaved deciduous forest are supported by these cyclonic activities while they are totally laking beyond the reach of maritime air. Moreover, high-latitude snowfalls sustain an advanced polar front position which in turn makes glaciation self-sustainable. Other factors, such as thermal insulation of polar lands or basins by a circumpolar current or, alternatively, by thresholds barring them from warm currents, are but transient and, though incidentally important, are dispensable in the general model.

In contrast, in the high sea-level epoches, neither epeiric seas nor shallower oceans, in which the psychrosphere was reduced or even replaced by warm salt waters, could sustain the sea/land thermal gradients required for feeding the heat machine. In consequence, the warm Earth was much drier lacking both equatorial rain forests and polar ice caps.

The greenhouse model: With a shrinking land surface, less CO_2 was spent in reactions with silicate minerals (one of the major CO_2 sinks, see Berner, 1990) and less of it was taken up by the warmer oceans. Therefore, during the high sea-level epoches more CO_2 remained in the atmosphere adding to the global warming as well as to the acidity of soils and water.

This additive CO_2 model is emphatically different from the currently hold views according to which CO_2 and other greenhouse gases are the sole factors of climatic change. These views are negated by the evidence of CO_2 changes lagging behind the glacial and oceanic events (Siegenthaler, 1990; Reynaud et al., 1993).

CO_2 fluctuations associated with El Niño, an anomalous warming of the Pacific surface waters, are especially instructive for they tell us what might happen, on a larger scale, during higher sea-level - warmer ocean epoches. The atmospheric CO_2 content falls, perhaps in conjunction with suppressed upwellings, then rises lagging several months behind the air and surface water temperature rises. Notably, the El Niño events are accompanied by rotational (length of day) fluctuations (Zheng et al., 1990).

Although secondary, CO_2 fluctuations might have been most important for the pH-dependent aquatic organisms and terrestrial plants which typically increase their productivity while decreasing the water uptake under a greenhouse regime.

CLIMATES THROUGH AGES

Palaeotemperature estimates are, as a rule, obtained by methods giving momentary values, hopefully but not necessarily typical for their ages. However important this information might be, the long-term climatic changes have to be evaluated by processes of comparable rates. One such process is a shift of the vegetational zones which stretch continuously (or sometimes discontinuously) across the continents. Not all zones are equally represented in the fossil record, but at least the broad-leaved deciduous forests or their extinct analogues as well as evergreen woody vegetation types can be recognized with some confidence. During the last 400 m years their boundary across Eurasia shifted between 30 and 55°N.

Such large-scale zonal shifts are usually associated with adequate sea-level fluctuations which is what to be expected in the light of the latter's great climatic significance, as discussed above.

According to phytogeographical information, there seem to have been three modes at which global climates have been stabilized (despite the secondary and higher order cyclicity) for appreciably long intervals of geological time. The evergreen/deciduous zonal boundaries at about 30°, 40-45° and 50-50°N are characteristic of the "cold", "temperate" and "warm" intervals, respectively. As revealed by this method, most geological-scale first-order boundaries are marked by a cooling usually followed by a rapid warming.

Accordingly, the atmospheric CO_2 contents, measured either directly in ice core samples or indirectly by the carbon isotope ratios or plant stomatal indices (e.g. Van Der

Burgh et al., 1993), could have been stabilized at about 200-280, 280-350 and 350-600 ppmv (Krassilov, 1994).

There were also intervals when evergreen plants grew indiscriminately all over the northern land. These seem to have been greenhouse episodes, for the plants were not only less restricted in their ranges by temperature, but also less sensitive to precipitation differences, indicating exceptionally high atmospheric CO_2 levels.

THE FOUR PHASE MODEL

From the outset of glaciation, climatic cyclicity in general and short-term climatic cycles in particular must have been strongly accentuated by the ice cap-climate feedback loops. Dinosaurs must have hardly experienced such climatic fluctuations as those which drew Abraham and his descendants from Palestine to Egypt and back every four hundred years.

The four phase model (Krassilov, 1994) was evoked to explain a succession of climatic events typical for the mid-latitude cycles in the Tertiary and up to the present. During a *warm humid phase*, seaborne ice melts extensively, excitating maritime polar front surges which in turn provoke mid-latitude cyclogenesis. While cyclones bring more snow to northern land masses, the polar front moves southward over the continents, opening the next *cold humid phase*. The advancing polar front then pushes cyclonic vortices down to the lower latitudes, bringing more precipitation to subtropical regions. At the same time, polar regions receive less snowfall, and the polar front retreats. Eventually, a *warm dry phase* is brought about by subtropical front outbreaks forming warm anticyclones which block a steady flow of westerlies.

Blocking by either cold or warm anticyclones or by stable cyclone-anticyclone pairs (Wallace & Blackmon, 1983) is a characteristic feature of the present-day and perhaps even most of the Pleistocene climate. Their long-term effect is felt in the discontinuous latitudinal zonation with zonal boundaries sometimes turning meridionally, as, for example, the broad-leaved forest's eastern boundary along the Urals or the dark conifer/larch taiga boundary at the Yenisei River in Siberia.

Upon this model, atmospheric CO_2 fluctuations form an integral part of climatic cyclicity rising in the warm dry phase with a shallower oceanic thermocline and falling in the cold humid phase. Climatic contrasts might have been accentuated by the greenhouse positive feedback. However, as our recent experience shows, the climatic system does not respond appreciably to greenhouse gases. It is true that the steadily rising CO_2 emissions in the XX century have been accompanied by a warming of about 0.5°C. But most of the warming took place between the late 1910's and the 1940's, with a subsequent cooling extending into the late 1970's. The next warming in the 1980's only slightly exceeded the 1940 level.

Extending the Biblical cyclicity, we are approaching the end of another 400-year period, hence facing hard times.

STRATOSPHERIC OZONE

Stratospheric ozone depletion is currently attributed to industrial chlorflurocarbon (CFC) emissions which in theory could destroy ozone by heterogeneous reactions on ice particles in stratospheric clouds. Like the anthropogenic greenhouse model, this model is entirely in the modern spirit of reductionist *ad hoc* explanations.

Actually the polar ozone "holes" appear in association with the spring time polar vortices which suck in the ozone-poor maritime air and eject it into the stratosphere. The "holes" vary from year to year in relation to oceanic temperature anomalies and other climatic phenomena, affecting the dynamics of polar air and, in particular, the dimensions of the polar atmospheric cell.

The stratospheric ozone dynamics might then be closely related to global climate changes. Therefore we can expect even more drastic long-term ozone column reductions in association with large-scale climatic fluctuations of the past geological times, notably during the warmer phases. The typically more strongly dissected leaves and thicker cuticles of Mesozoic plants in comparison with the present-day flora might be evidence of far larger ozone holes involving the middle latitudes.

Periodic ozone depletions having some, though hardly estimable, mutagenic effect, they might have acted thus in concert with other factors of environmental instability.

IV. BIOTIC CHANGE

The idea of environmental change as a direct cause of biotic change was popular in the pre-Darwinian time, the more so as it was based on concomitant records of environmental and biotic events in sedimentary sequences (e.g., in the Paris Basin studied by Cuvier).

Along with advance both in geological and biological knowledge it became increasingly hard to believe that many species had simultaneously perished all over the Earth because of a flood, a cooling, an igneous activity or a cometary impact. In the intellectual atmosphere of today, however, such straightforward explanations seem no longer out of place, and some of them have been actually revived (e.g., the impact theory, see above). But the XIX century Darwinians would deny any cause and effect relationships at all rather than indulge the naivete of the Cuvierians.

Paradoxically, it was A. R. Wallace who coined the term "Darwinism" in its modern, non-Palleyan, meaning and who made a decisive breakthrough in solving the problem of environmental impact on evolution (he is remembered mostly as a one-time competitor who instigated the publication of the Darwinian theory; his more important contributions have not been appreciated until recently). It was he who found a correlation between biodiversity and environmental stability which is the cornerstone of ecosystem evolution.

BIODIVERSITY: A POSITIVE FEEDBACK ENHANCING

Diversity is an informational parameter pertaining to the structural complexity of a system. Biological diversity, or biodiversity, pertains to biological systems of all levels and the different elements thereof. For example, a genetic system is characterized by the diversity of nucleotide sequences, while the diversity of organismic systems is to be measured in morphological structures or physiological processes.

In ecosystems, living matter is produced and processed by a number of producers, consumers and destructors occupying the respective functional niches. Since all or most of the niches are filled with different species (or, as it were, subspecies, varieties, etc.), the ecosystem structural diversity is manifested through taxonomic diversity. This is alpha diversity multiplied by the beta diversity of biotic communities (Whittaker, 1975).

Though diversity plays the key role in evolution, a theory of diversification is not yet accomplished (Wilson, 1992). The following crude scheme is suggested here:

(1). In theory, as a starting point, there could be a single highly tolerant species filling all the ecological space.

(2). The reasons for this species to give room for other species may be that, along with population growth, some resources approach their limit, thereby decreasing the tolerance in respect to other environmental factors (tolerance is known to be sensitive to a resource deficiency, see Odum, 1959) and, therefore, narrowing the ecological potentials, or niche.

(3). Division of an ecological space into specific niches potentially converges on the basic environmental heterogeneities, or "grains", with any additional species in turn adding at least one new grain, thus impelling a further growth of diversity.

(4). Diversity growth is limited by the minimal niche size, in turn depending on the minimal sustainable population density.

(5). Insofar as a sustainable population density is negatively correlated with environmental stability (in an unstable environment, populations must be more redundant, thus buffering themselves against the devastating impacts), ecosystem diversity is eventually controlled by the latter factor. This will be discussed later in the chapter.

Ecosystem complexity is based on the redundancy of each trophic level, initially perhaps arising as a buffer against the devastating environmental impacts. Each trophic level can sustain some amount - normally about 10% - of its biomass to be consumed. Accordingly, there is an upward thinning sequence of superimposed levels known as the trophic pyramid. It is not immediately apparent why a consumer would hold at the 10 per cent level. But, on one hand, there is a negative feedback of resource exhaustion and, on the other hand, also a parasite-predator pressure. The latter tends to increase with population growth rendering it excessive. Incidentally, some malignant microorganisms, including HIV, seem to have been crossing from animals to man along with human population growth. In addition, there are various defence mechanisms keeping predation at the thresholds beyond which it is energetically unprofitable. Even palatable plants contain mild toxic allelochemicals, so that satiation is felt at a certain level of poisoning.

It can be considered an evolutionary rule that more highly evolved groups diversify and support the diversity of their mutualists at higher levels than their predecessors (compare, e.g., flowering plants with gymnosperms). In this way, ecosystem saturation levels tend to rise with time.

An ecosystem is saturated when all the potential niches are filled, but saturation is a reciprocal process, because organisms modify their niches as well as generate new ones. Each organism tries to secure an optimal site in the multidimensional ecosystem hyperspace pushing competitively inferior organisms to less favourable sites. Yet adaptation may turn the latter into new optima. An actual niche-splitting process is certainly more complex than this, but for our purposes the elementary differentiation principle would suffice. Incipient differentiation at one trophic level would open at least two potential niches at the next level above it. Their filling species, preying on each of the lower level species, would introduce an additional differentiation factor impelling further splitting of the latter, in turn augmenting niche potentials at the consumer level, and so on. Thus, various ungulate species coexist in the savanna grazing on different grass species which in turn diverge in response to their different grazers. In fact, the carrying capacity of savanna ecosystems depends on the structure of their biotic communities rather than on their species content (Fritz & Duncan, 1994).

To approach reality, we have to consider at least three levels. At each of them the diversity is potentially increased by differentiation at the next level below, above, or both, in turn conferring the diversification trend to these latter levels.

Thus, differentiation impulses spreading up and down the trophic pyramid impel the diversity to increase in a geometric progression. Since the real diversity progression is usually logarithmic, we have to assume that a negative feedback factor intervenes, breaking down the positive feedback-enhancing machine.

THE STABILITY-DIVERSITY MODEL

Ecosystems are biogeochemical circuit machines which are the more effective the more closed the circuits, i.e. the less waste being accumulated. It is known that some ecosystems are more wasteful than others, e.g., more litter accumulates in the tundra, desert or temperate forests than in tropical forests. Apparently, these distinctions depend on complexity, resilience and environmental stability, but the relations are not immediately evident.

In the temperate forest/tropical forest comparison, the tropical forest is not only less wasteful but also taxonomically more diverse showing that both things go together. Thus for any ecosystem it seems better to be more diverse, but obviously there should be some limits to their capacity to store species.

While an ecosystem is evolving to its maximal diversity, its trophic resources are divided between more and more species, so that a share of each coexisting species is diminished. Accordingly, these species are stimulated to use their resources more efficiently. They can no longer afford a redundancy in feeding and reproduction. They adopt more economic and more precise feeding and mating techniques (incidentally, many plants shift from wind pollination to animal pollination) sustaining their populations at lower densities. As a rule, the more species per community the less individuals per species.

One very good palaeontologist but perhaps not so good an environmentalist has argued against the protection of such rare animals as the giant panda (a symbol of the World Wildlife Fund) which is doomed to extinction all the same by being too slow, fastidious and sexually inapt. Yet the panda is rare not because it is inapt. On the contrary, it is so apt that it can afford being rare, while the less efficient species use redundancy as a buffer from extinction. What threatens the panda is not its slowness but a destabilization of its environment favouring redundancy strategists.

Thus the limit to diversity is put by redundancy as a buffer from extinction. Stable ecosystems are characterized by a lower redundancy level than the less stable ones. Schematically, for each ecosystem there is a minimal sustainable population density **n** at which **s** resources can be divided between **s/n** species. While the ecosystem is destabilized, the sustainable density has to be increased by **r** redundant components, so the diversity will be limited to **s/n+r** species. Therefore **s/n-s/n+r** species have to die out.

Actually, under environmental stresses the rare species tails of the density/diversity curves are cut off. Yet the profound global environmental changes discussed above have had even more far-reaching consequences of not only the rare species but also the dominant species being selectively exterminated.

THE CLIMAX CUT-OFF MODEL

The major boundaries of the geological time scale have been originally drawn at apparent diversity minima in the fossil record coinciding with large-scale environmental changes. In the Darwinian times, these were attributed to imperfection of the fossil record. However, the modern, more precise and chronologically controlled recording has confirmed the periodical falls in biodiversity at or close to the boundaries of the major geological time-scale divisions. The losses of biodiversity have been calculated for various taxonomic ranks (e.g., Raup et al. 1973; Sepkoski et al., 1981) but the estimates are biassed by taxonomic as well as numerical complications.

One thing is beyond any reasonable doubt, however: the first-order time scale boundaries are marked by declines and replacements of the major dominant groups, e.g., pteridosperms - cycadophytes - angiosperms or therapsids - dinosaurs - mammals.

It must be mentioned that successions like these are not necessarily phylogenetic. In fact the mammals are phylogenetically closer to theraspid reptiles than to dinosaurs, while the angiosperms share perhaps more characters with the Palaeozoic seed-ferns than with the Mesozoic cycadophytes. Apparently, the course of ecosystem evolution can be better described as winding rather than straightforward. This can be taken as another evidence of environmental and biological change being intimately interrelated.

As it was outlined in the preceding chapters, global environmental changes could be triggered off by Earth's accelerating rotation rates acting differentially on the exterior plates and interior spheres of different densities, their strike-slip or overslip motions causing concerted tectonic, magmatic, sea-level and magnetic events.

These processes and, especially, sea-level fluctuations alter the Earth albedo as well as the thermal capacity of the oceans bringing about profound climatic changes feedback-looped to oceanic circulation. Climatic changes affect the interrelated oxygen and carbon cycles, chemical weathering of silicate rocks and carbonate sedimentation - major CO_2 sinks - thus invoking greenhouse or freezehouse feedbacks.

This brief reiteration of the global environmental change models shows that virtually all terrestrial and aquatic ecosystems must be affected.

No wonder then that dominant terrestrial and marine groups, such as dinosaurs and ammonites, tended to disappear at roughly the same chronostratigraphic level. Dinosaurs perished at a time of global regression and cooling. Though perhaps these environmental events could have been tolerated by themselves, for among the dinosaurs there were both cold-blooded and warm-blooded forms well-adapted to a wide range of climatic situations, the concomitant vegetation changes might have posed a more serious problem.

Already at the beginning of the Cretaceous period, the largest vegetarian dinosaurs must have been driven to extinction by a drastic shrinking of the fern-horsetail marshes, their favourite feeding grounds. Then, in the middle of the Cretaceous, when primitive small-leaved angiosperms had replaced large-leaved cycadophytes in the widespread shrub communities, dinosaurs had to meet a tremendous challenge of available leaf mass shortage. Various beaked forms with grinding teeth raised to dominance at that time. But the all-embracing end-Cretaceous vegetational changes must have been of the kind any larger gregarious animal could hardly cope with. While epicontinental seas retreated, the climate became cooler and more humid (counterintuitive, because inland seas hamper cyclonic activity). Mixed deciduous forests advanced over the open shrubby landscapes which supported the largest populations of dinosaurs. Transition from an open and highly resilient vegetation to deciduous forests might have costed these animals a severe reduction of their populations making them more vulnerable to any accidental hazards. Many marsupial and multituberculate species vanished with dinosaur communities leaving the scene open to some obscure marginal mammals.

In the sea, the great extinction wave covered the most advanced planktonic foraminifers furnished with keels and other projections enabling them to accomplish vertical migrations and persist at a selected level of a stratified water column. Along with regression and cooling, a thermohaline stratification of oceanic waters was replaced by a psychrospheric one with cold deep waters, disrupting not only planktonic communities, in which the less diverse and morphologically more primitive forms were brought forth, but also benthic inoceramid communities adapted to a mild oxygen deficit. Extinction then ascended the food chains to marine reptiles and birds.

Notably, among the reef-builders, the most advanced and late appearing (both in the geological history and in the succession of reef organisms) bowl-shaped rudistid mollusks died out and have become subplanted by primitive and, in both senses, earlier evolved bryozoans.

These latter examples enable us to proceed from *ad hoc* to general explanations. In the early biocoenotic models, biotic communities were conceived of as superorganisms which pass from their juvenile state to maturity through a series (or sere) of pioneer, successional, subclimax, and climax species replacing each other in a regular manner. These views have been much criticized as oversimplified and remote from biological reality, which is what they certainly were. However, they apparently held truth enough for having never been entirely discredited even by the most modern theories such as the "carousel" model (van der Maarel, 1991) according to which a perpetual turnover rather than stability is the norm for the so-called climax communities. Each fallen tree opens a window through which various pioneer and successional species penetrate the climax.

However, with a new factor of instability being added, the carousel might not complete its round. In other words, under an environmental stress, the succession can be halted at a transitional or even a pioneer stage never reaching the more advanced one that, in a more predictable environment, represents the climax. If this situation, known as disclimax, is but temporary, in all probability the former climax will be restored. If, however, it lasts for a longer time (an ecologically "long time" is a few hundred to several thousand years, that is, not appreciable geologically), the former climax species - and these are the most prominent species of their time - would find themselves in trouble, and some or even all of them would eventually perish.

Moreover, a higher-rank taxon consisting of climax species would die out as a unit making a typical mass extinction as we see it in the geological record. For such taxa are diverse and prominent both by aspect and number which render them dominant. The patterns of species arrival have been defined with some confidence for reef communities; hence we know the rudistids, a mollusk order, comprised climax species which all disappeared at the end of the Cretaceous. Dinosaurs are more difficult, but it is conceivable that after some 150 m years of dominance most of them tended to climax communities. The Cretaceous mammals certainly included both climax and pioneer species, and the latter seem to have been the only survivors.

With the climax cut off, the surviving species find themselves in a drastically undersaturated community for them to fill, whereupon they start a new round of climax build-up.

BIOMASS VS. PRODUCTIVITY

Ecosystem operates transforming non-living matter in the living one. The output of living matter, or productivity, is limited in almost all ecosystems by the efficiency of photosynthesis (or of chemosynthesis for some bacterial ecosystems). However, ecosystems differ widely from one another in the amount of both their production which is actually added to their standing biomass and that which compensates for the losses or is wasted.

Ideally, each open system tends to a larger volume (standing biomass) by which its enthalpy - a measure of incoming energy stored as internal energy - can be increased. However, in unpredictable environments, ecological successions from pioneer communities to the climax are abbreviated (see the above climax cut-off model) resulting in accelerated turnover rates. Under such conditions, biotic communities have to keep their biomass low while increasing their productivity to compensate for heavy losses. A normal trend can be restored in consequence of either the environment being stabilized or the sustainability increased by adaptation.

In the trend to a higher standing biomass to productivity (B/P) ratio, productivity typically gets under internal control instead of being regulated by negative feedbacks alone.

Historical developments seem to agree with this scheme. The primaeval microbial ecosystems had a small biomass, perhaps no more than a film or a thin mat on rocky substrates, but their productivity must have been considerable. This is evidenced by the great thickness of banded iron ores as well as by the comparatively high heavy carbon (^{13}C) ratio - a crude measure of biotic productivity - in Proterozoic limestones. Iron might have been used to bind up oxygen, a poisonous byproduct of primitive photosynthesis. The cyanophyte ecosystems tolerant to oxygen might have oxidized the atmosphere which made land habitable by screening ultraviolet radiation with stratospheric ozone.

First land plant communities must have been formed by small leafless vascular plants with massive subterranean rhizomes. They could spare their whole subaerial parts while their more robust descendants shed their lateral branch systems. Leaves appeared much later not only as photosynthetic organs but also as depots for secondary metabolites which then could be excreted by shedding or cropping of the leaves. Leaf production started a new era both in plant-animal interactions and internal productivity regulation. The latter provided for the B/P ratio being rapidly increased.

The most wasteful negative feedback regulation has been left to pioneer communities which have a comparatively small standing biomass, are overproductive and typically consist of short-lived plants or larger plants with small leaves. In the course of an ecological succession, the historical development of the terrestrial ecosystems is briefly repeated, as it were.

COHERENT VS. NON-COHERENT TRENDS

While the system goals are set in by the thermodynamic laws, the goals for their constituent elements are defined by the developing systems themselves. An ecosystem biassed toward a higher diversity and B/P ratio sets its constituent populations in upon a trend to an increased efficiency of utilization of its trophic resources to be shared among more members. A generalist species exploring a wide range of environments cannot perform with equal efficiency in all of them. It would find itself restricted to those environments in which it is superior to its competitors. Consequently, any traits related to the abandoned environments would lose their phenotypic expression while they can be retained as latent genetic potentials or even shed from the genotype. Such losses are, as a rule, compensated for by advancements directed by the partitioning of ecological niches.

Thus, a coherent evolution (Krassilov, 1969 and elsewhere) promotes a "coarse-grained" population strategy (Levins, 1968) upon which even slight environmental heterogeneities can sustain the coexistence and divergence resulting in an ever narrowing niche overlap and in well-defined species as well as in a high taxonomic diversity (see above).

This mechanism would explain the paradox of high specialization: why going to such lengths when the much less specialized organisms also survive? However, in the coherently evolved communities generalists can survive only as pioneer or early successional species.

Specialization is the only trend recognized - though not fully understood - by the traditional evolutionary theory which assumes that specialization increases fitness as measured by population growth. Actually, upon the specialization track, fitness is manifested in a decrease in sustainable population densities at the expense of their redundant components (see above), thus providing for a rising diversity. However, under heavy environmental impacts causing a retrograde development of biotic communities (see the above climax cut-off model) this trend can be halted or even reversed. While the diversity and B/P ratio decrease alongside with increasing turnover rates, high premium is laid on the "fine-grained", expansionary, highly productive generalist strategy. Latent variability, no longer constrained, would then expand to full swing.

The coherently evolved species are restrictive not only to their own potential variability, but also in respect to any alien genetic material, for they are adapted to a certain environmental grain, while a gene flow from outside would, in all probability, infringe upon their carefully attuned fitness. Various protective measures are taken against any possible genetic invasion making these species more sharply separated, a considerable part of their bizarre morphology being just distinctions for the sake of distinction.

In contrast, a non-coherent evolution striving for an ecological expansion would only be facilitated by an inflow of genetic information either in the form of hybridization or mediated by viruses or other microorganisms capable of genetic transduction. Accordingly, the species barriers would become more transparent while genetic introgression would enhance the internal mutation rates sometimes actually worked up to explosive mutagenesis (Golubovsky et al., 1974). These processes contribute to a genetic enrichment as prerequisite for an ecological expansion and a morphological innovation.

A prominent feature of non-coherent evolution, entailed by its experimental character, is accelerated developmental and reproductive rates. Incidentally, both angiosperms and mammals have typically higher growth rates than gymnosperms and reptiles which they replaced, respectively, during the mid- and terminal Cretaceous non-coherent phases of ecosystem evolution. Although pertaining, in the first place, to environmentally enhanced rates of ecosystem turnover, developmental acceleration has far-reaching consequences at the morphological level.

THE LETO VS. NIOBE POPULATION STRATEGIES

Leto, the mother of Apollo and Artemis, was ridiculed by the prolific Niobe for having so few children. But Niobe failed to protect her children from the arrows of Leto's twins.

The Leto strategy is to invest in a fewer but well-protected offsprings, while Niobe relies on sheer numbers of her redundant progeny.

As it follows from the above discussion, the choice between this or that strategy is not accidental, being determined by the prevailing trend of ecosystem evolution. A coherent evolution promotes the efficiency in exploring a selected environmental grain. While efficiency is incompatible with redundancy, the coherently evolved populations are less redundant and are sustainable at constant densities and equilibrium gene frequencies. Upon a non-coherent trend, redundancy is necessary as a buffer against extinction. In unpredictable environments, populations experience large density fluctuations (or population waves, as is the case in Arctic lemmings) and periodic bottleneckings which disturb equilibrium gene frequencies.

Both Leto and Niobe strategies may occur in a single ecosystem but they prevail at different stages of its development. As a rule, pioneer species are Niobe strategists while climax species are Leto strategists. More ancient organisms tend to be on the Niobe side which may indicate a historical progression towards the Leto strategy. Though ancient is not necessarily primitive, this progression shows that there must be some sense in our intuitive notions of primitiveness and advancement.

At last we can avoid circular reasoning inherent in the survival-of-the-fittest formula, with the fittest being those which eventually survive. Both strategies may ensure survival but they are by no means equivalent from an ecosystem point of view. For ecosystems as a whole evolve towards a more efficient, less wasteful, production of living matter (lower entropy production rates in thermodynamic terms), while Niobe strategists survive at the expense of a sizeable part of their population being wasted, hence increasing the total entropy production in their ecosystems. The Darwinian fitness pertains to population growth irrespective of its redundancy. In contrast, ecosystem fitness pertains to entropy production rates to which the co-evolving populations can contribute by being non-redundant. It is in respect to the latter meaning of fitness that evolution makes sense.

CYCLIC SPECIATION

Charles Darwin pleaded to put an end to the unbearably protractive disputes over the species problem, but failed to show how this could be done otherwise than by conventions. And conventions are good in helping a problem out of science rather than in solving it.

Actually the problem of species goes back both to Plato, who considered essences to be more real than things, and Cynics, who would see a horse but refused to perceive the horse as an idea of horsiness. The Darwinian notion of species came close to that of Cynics. Essentialism became one of the STE taboos. But why bother about species if there is no essence in it? To all appearances dogs recognize cats as a species in much the same way as humans do, though they treat them differently.

Species is a category of things perceived as a whole because of their essentially similar qualities endowing upon them a particular place in nature. In defining the species scientifically, various operational criteria, such as mating, can be used as far as they reveal the essence if but in an oblique way. Certainly the intercrossing can be used as a criterion after and not before the species is perceived on other grounds. Adherence to the intercrossing criterion has led some biologists to insist that species exist in heterosexual organisms alone. However, reproductive isolation is only one of the means for protecting the species integrity from an inflow of genetic material. There is no serious reason for discarding as species all well-defined units that protect their biological integrity by other means.

Speciation is traditionally conceived of as an occasional discontinuity in the gene flow caused either by a geographical barrier (with a subsequent divergence) or a mutation breaching interfertility, or their combinations as in the founder model (Mayr, 1954, later developed into the punctuated equilibrium model by Eldredge & Gould, 1972, and the flush-crash-founder cycle model by Carson, 1975). Randomness is a common feature of these models perhaps inherited from a Cynical attitude to universals.

Probably also related to this creed, there was (and still is) a strong opposition to sympatric speciation even in such obvious cases as speciation bursts of cichlid fishes in African lakes. The opponents have managed to render these cases not so obvious, at least for the Great African lakes; recently, however, similar speciation bursts have been discovered in small crater lakes (see Schliewen et al., 1994). Since evidence is derived from nature, any mathematical objections to sympatry may pose a problem to mathematicians, not to natural scientists. In the coherent evolution model (above), speciation is conceived of as a normal outcome of ecosystem development trending towards a more efficient use of each environmental grain and thus promoting a coarse-grained population strategy. Populations setting out to explore even but slightly different environmental grains must develop some adaptive differences which can be eroded by outcrossing. Isolation by hybrid inferiority alone is wasteful, so a more efficient mechanism must be found.

Incipient isolation is achievable by the mating preferences either of dissimilar (to avoid incestuous mating) or essentially similar (to avoid outcrossing) individuals. Wobbling between these extremes, the mating preferences become eventually fixed either behaviourally or physiologically. Incidentally, in the case of Hawaiian *Drosophila* taken as evidence of the founder effect, the mating preference model seems more convincing than the currently held gene drift revolution model. Founders of a new colony encountering their kin alone would have to reconsider their mating preferences as Lot's daughters did; new conspecific arrivals would then be treated as of different species. For fixation, any improvised means would do, and so it may seem accidental, as is the case in *Tribolium* beetles where reproductive isolation is conferred by parasitic microorganisms and is curable by antibiotics (Wade, 1985).

While ecosystem evolution is switched to a non-coherent track, any subtle adaptive distinctions would be swept away by an undiscriminating fine-grained population strategy. The outcrossing barriers thus would be no longer essential. Introgression and even fusion of species would turn advantageous as a means of genetic enrichment along with an aroused latent genetic variability, microbial transduction and mutation bursts. The issuing polymorphism would sometimes exceed even typical intergeneric distinctions (see Krassilov, 1989a, for palaeontological examples).

During the next cycle, *macropolymorphic* populations would segregate all over their wide ranges into genotype clusters adaptable to different environmental grains as incipient narrow species of a coherent phase.

Actually, at least in some taxonomic groups, broad species, sometimes called linnaeons or "superspecies", are distinguished as systems encompassing a number of narrow jourdanons or "semispecies" (Vavilov, 1930). Such systems can appear in the course of cyclic speciation.

CONGRUENT MORPHOLOGY

Morphology contemplated as being congruent with habits and environments has given rise to the concept of adaptation - evolution in the Darwinian sense. One time the congruence has been thought of as resulting from special training, i.e. a preferential use of some organs, perhaps at the expense of the others. This view has been ascribed to Lamarck, although he shared it with a number of his contemporaries. In Charles Darwin's times, English gentlemen took to sports and horse breeding, hence they knew that training achievements were not or not fully heritable while selective breeding could be quite effective. Thus the selection paradigm has been brought forth to replace the use-disuse paradigm. Since artificial selection tends to enhance maladaptive traits, a consistent conclusion would be that selection can destroy adaptation, yet this aspect seems to be overlooked.

An alternative theory, championed by Berg (1922), maintains that structures appear irrelevant to any needs that have been conferred on them in respect to the subsequently chosen habits and environments. This model is called **saltational**. The STE has launched attacks on both Lamarckian and saltational models, both being eventually tabooed from evolutionary biology.

Two opposite trends of ecosystem evolution discussed above as far as they implicate morphology may predict two kinds of morphological change. One is induced by the efficiency of performance in the target environmental grain. The horse hoof, giraffe neck and elephant trunk fall into this category. As a rule, they can be easily homologized, i.e. traced to the respective but less advanced traits in the ancestral forms. Their origin is thus not saltational but related to a certain incipient need conferred by a coherent evolution, whatever the genetic mechanism. The latter will be discussed in the following chapter.

In contrast, upon the non-coherent track of a high turnover rate, efficiency is less important than a rapid growth, an early sexual maturity and a high reproductive potential. Accordingly, a tendency towards an accelerated development is bestowed on all non-coherently evolving populations. The consequent morphological changes would range from spatial and/or temporal shifts of developmental stages (heterotopy or heterochrony) to a profound paedomorphic restructuring of which neoteny - larval sexual maturity - is an extreme case.

Schematically, a life cycle can be shortened in two ways: either by truncating or condensing the development. In the truncation mode, the terminal stages are cut off, perhaps in parallel with the climax cut-off (above). In the condensation mode, some early to intermediate stages are abbreviated, combined or deleted.

These changes must be saltational. As a rule, no intermediate states can be found either by comparative morphology or in the fossil record, while the issuing structures are difficult to homologize with any particular ancestral structures. Classical morphology has treated them as *sui generis*, that is, having no identifiable antecedents.

Moreover, a saltational restructuring conforms to no special needs other than the wholesale need for a rapid development and proliferation endowed by ecosystem evolution. However, saltations are of great potential for further evolution in respect to any narrowly defined requirements, for the early developmental stages as well as the ontogenetically superimposed confluent structures are more plastic than the more stringently determined - definite - stages and structures. In plants, a precocious development (e.g., fertilization before the female sex organs - archegonia - are properly defined) and organ fusion are the most common ways of arriving at an evolutionary novelty (e.g., double fertilization), while in such advanced groups as flowering plants most morphological structures seem *sui generis*, i.e. derived from two or more congenially fused organs of their gymnosperm ancestors.

Plant organs develop from mitotically active - meristematic - primordia. They fuse in meristematic state or else at later stages by their marginal meristems. In the former case, the wholesale primordial fusion results in the exceptionally plastic hybrid meristems giving rise to chimeric structures. When a new need is involved, such as protection of seeds, it is more often than not that chimeric structures, such as carpels or syncarpic ovaries, are endowed with a new function (Krassilov, 1989b).

Perhaps less straightforward yet essentially similar morphological restructurings occur in the evolution of the animal world. In the 1920's to the 1940's, British developmental biologists endeavoured a revision of Haeckel's recapitulation law according to which the individual development is a brief repetition of the evolutionary history. They pointed out that juvenile ancestral characters may appear at some late - instead of early - developmental stages. Such characters (e.g., those of juvenile apes in adult humans - Bolk, 1926) are paedomorphic. It was shown that paedomorphism could have been responsible for a rapid morphological change contributing to the origin of higher taxa, notably vertebrates (Garstang, 1928; de Beer, 1940).

Still earlier, American palaeontologists formulated the laws of developmental acceleration and retardation governing the macroevolutionary processes (Hyatt, 1886; Cope, 1887). Their observations led to the orthogenetic concept (Eimer, 1898), postulating for all the members of a higher taxon a typical succession of developmental stages. Accordingly, the intragroup diversity may arise from the developmental succession being halted at one or another stage.

In Russia, Severtzov (1939) and his school showed that widely disparate evolutionary trends would result from developmental changes occurring at early, intermediate or late stages of ontogeny.

Perhaps this approach has been somewhat excessively formalized (Rensch, 1954), yet it can give us a clue to macroevolution as not a mere sum of microevolutionary events. Unfortunately, it has never been popular in the framework of the STE, ever suspicious - perhaps not without grounds in this case - of essentialism and the inheritance-of-acquired-characters heresy.

ACQUIRED CHARACTERS

The most dramatic debate about the acquired character inheritance problem thundered in the 1930's and 1940's when virtually nothing was known of the mechanisms of inheritance. This reminds us that scientists came of the clergyman stock.

Inheritance of acquired characters is an unfortunate expression, for all characters have been acquired in one way or another. Very different things are meant by this, such as (1) a genetic transmission of life experiences, (2) a genetic fixation of adaptive morphological or behavioural modifications, or (3) a direct adaptive reaction of a genetic system to environmental stimuli. But why bother about semantic distinctions, when acquired characters, in all possible meanings, are just the same nonheritable?

The idea of heritable life experiences goes back to Aristotle and it had a turbulent history culminating in Lysenkoism, a political servitude of natural science (and by no means its sole form, for there were also a Nazi anthropology and other, less extreme, versions). Charles Darwin was compelled to accept the inheritance of modifications in his studies of instincts. Freud was an adamant supporter of this kind of inheritance, obligatory for his theories.

Science is often conceived of as a set of limitations telling us what is inadmissible even as a hypothesis (Marconi had repeatedly been told that a long-distance transmission of radio signals was impossible; fortunately he would not hear). In genetics, such limitations had insistently been set forth even before this science could formulate the definite ideas of what genes were and how they worked.

With advance in molecular genetics, most of the earlier abstract notions, such as "genes" or "mutations", have been transferred, without proper semantic assessment, to the molecular level. This has led to a perpetual confusion with no end in sight. Can a macroscopic notion of the mutation as a random heritable change be "confirmed" by molecular research if mutations have different meanings at the organismic and molecular levels? While the organismic mutations have been conceived of as irreversible changes regardless of the environment, the molecular mutations are reversible changes highly dependent on their chemical environments.

The polemical anti-Lamarckian slogan of adaptive modifications being nonheritable has been automatically brought down to the molecular level where it is virtually meaningless. Nevertheless, until recently the claim of a direct adaptive genetic response has been hotly disputed about and disproved or rendered ambiguous on methodological grounds (e.g., Lenski & Mittler, 1993).

To circumvent the difficulty of arriving at a complex adaptation by means of random mutations, a number of roundabout solutions have been suggested, such as "*Dauermodifikationen*" (Jollos, 1913), "the Baldwin effect" or "genetic assimilation" (Waddington, 1962) meaning, in essence, that a mutation forwarding the evolution along a selected pathway may be more probable or at least more readily fixed than any deviating mutation. For many years, students have been told that Waddington, though essentially a trustworthy researcher, unfortunately brought his assimilation concept too close to the inheritance-of-acquired-characters heresy, that he might have meant a different thing and, at any rate, genetic assimilation, if exists, must differ from what Waddington meant by it (see, e.g., Sharloo, 1991).

However, at least in unicells, there are no serious obstacles to a direct adaptive response by an adequate DNA modification and, in fact, this has been demonstrated by Inderlied & Mortlock (1977), Perlman & Strickgold (1977) and, more recently, by Cairns et al. (1988) in their lactose experiments. Even in some flax varieties, adequate genetic changes directly affecting the body size can be brought about by an excessive input of fertilizers (Durrant, 1962; Callis, 1973 and elsewhere).

Actually, generative cells are less independent of the soma in plants than in animals. They are differentiated at a late stage of meristematic development during which some adaptive DNA modifications can be introduced in the cell clones by environmental factors. Even one branch can be heritably better adapted than another, and the fruits of that branch may have some selective advantages over the rest produced by the same plant (Primack & Kang, 1989). After all, plants are colonies rather than individuals. But the differences between plants and animals seem to be of a quantitative nature alone.

Yet all this is a side issue in comparison with our ignorance of the functioning of the genome as a system and not as a mere collection of various genes.

SYMBIOTIC GENOMES

Eucaryotic cells contain nuclear and extranuclear genes, the latter belonging to symbiotic organisms now functioning as cell organelles, chloroplasts and mitochondria (Raven, 1980). Moreover, some of the nuclear genes (notably the cellular oncogenes) are descendants of viral symbionts. Whatever the origin of the nuclear genome, it has been symbiotically modified and enriched in the course of evolution.

By these considerations we are led to consider the relations between organisms and their genomes as essentially symbiotic and not unlike those between the algae and fungi in lichens.

Consequently, the notion of "selfish genes" is meaningless, for the total genome as a system must be selfish but, like other mutualists, the interests of organisms and their genomes concur. Genome survival depends upon the survival of the organism. Therefore genomes are "interested" in a faithful reproduction of their carriers, if the latter are well-adapted and sustainable. They are likewise "interested" in improving their carriers rendered maladaptive by environmental changes. Yet any improvement has to be encoded in the genome by some structural changes. Thus we have in fact co-evolving systems bound up by a feedback loop. Like an organism, the genome briefly recapitulates its history in the course of development. Early genes construct an organism fairly different from the final target - the definite stage - more resembling some remote ancestors. Subsequent ontogenetic stages are completed by a more evolved genome.

Incidentally, in periodically shed and renewed organs, such as the antlers in the deer family or the exoskeletons in the crustaceans, each round brings about some directional changes, e.g., in the number of antler appendages. Although the genes may be the same, the genomes must be different.

While the organisms are led by their genomes through a series of developmental stages, the genomes in turn undergo directional changes conferred by developing organisms.

DEVELOPMENTAL PARALLELISM OF GENOMES AND ORGANISMS

The above scheme of genome-organism developmental parallelism contradicts the traditional notion of all cells of a multicellular organism having identical genomes. Yet at least some organisms, such as nematodes, are known to shed large heterochromatin blocks just at the onset of their ontogeny (Goday & Pimpinelli, 1984). Although heterochromatin components can contain no protein-encoding genes, they affect the genome as a system through the position effects and chromosome linking (chiasma formation) at cell division.

What happens to nematodes can just illustrate, in a most spectacular form, the genome changes commonly occurring in the course of development. In fact, heterochromatin losses have been reported in insects (Nur, 1967 and subsequent studies) and vertebrates (Perlman et al., 1976). These studies are consistent with the earlier cytological observations of a variable amount and appearance of heterochromatin in the cells of different adult tissues.

While euchromatization is characteristic of embryogenesis, the opposite trend of heterochromatization prevails in ageing organisms. These processes are documented in various classes of multicellular organisms enabling us to evoke a general model of euchromatization-heterochromatization developmental genomic cycle.

Cell differentiation and senescence seem related to the above cyclic changes, affecting the proliferative activity and chromosome pairing as well as the rates of transcription and enzymatic repair of genetic defects (see review in Krassilov, 1980). In ageing humans, chromosome breaks and losses are definitely associated with the genome's wholesale heterochromatization.

There are significant similarities between ageing and carcinogenesis, also accompanied by aneuploidy, chromosome breakage and a decreased efficiency of enzymatic repair (Tiepolo & Zuffardi, 1973; Marx, 1978; etc.). However, while in malignantly transformed cells the proliferation rates grow, we can expect reversions of a normal developmental genomic cycle associated with cell differentiation.

The reversions can involve not only large blocks of redundant (non-transcribed) repetitive DNA, but also (and perhaps more significantly) those essential repetitive sequences that are located within such blocks. Among those which show detectable changes during the development are ribosomal (rDNA) and histone genes. Since these genes are highly repetitive, they replicate somewhat slower than most of the non-repetitive, or unique, sequences. In effect, in the course of cell proliferations, they can be systematically underreplicated, so the number of copies and the total dose decrease through a succession of cell generations.

According to the rDNA underreplication model of cell differentiation (Krassilov, 1980), the rates of cell proliferation decrease in parallel with rDNA cistrons, and at a certain stage cell lineages enter a differentiation stage of their development.

At the same time, a premature loss of rDNA due to abnormally high underreplication rates results in a decreased number of cells per organ, morphological reductions (e.g., reduced bristles in "bobbed" fruit-flies), retarded developments and the retention of juvenile (paedomorphic) features (Yunis &Yasmineh, 1971).

Since in case of a rDNA deficiency a normal synthesis of ribosomal RNA can be restored by "magnification" due to a sudden increase in the number of ribosomal cistrons, it has been suggested (Krassilov, 1980) that sudden proliferative bursts in tumors, as opposed to the normal development, can be caused by "overmagnification" as a component of the malignant transformation process.

Thus a number of developmental phenomena seem related to the directional - though reversible - rDNA changes, while a concurrent underreplication of histone genes may affect both transcription rates and enzymatic repair.

Interspersed intermediate repetitive DNA sequences represent another component of the genomic system involved in directional change. Quantitative changes during the development have been confirmed in certain clusters of repeats (such as the Alu family), summarily constituting about 30 per cent of the total human genome (Cinelli & Corneo, 1976). Underreplication of the slow-replicating intermediate repeats has been reported in larval *Drosophila* DNA (Woodcock & Sibatani, 1975). It has been repeatedly suggested that interspersed repetitive DNA is involved, in one way or another, in gene activity regulation (Britten & Davidson, 1969; Holliday & Pugh, 1975). According to the mitose counting model (Krassilov, 1980), interspersed repeats are underreplicated at each of the successive cell divisions, serving as a metronome for the genes which are turned on sequentially at a certain stage of the repeat deleting process.

Incidentally, the deletion of intercalary DNA between the genes of the constant (C) and variable (V) regions of immunoglobulin molecules may turn on the V region. At any rate, these genes are kept separate in embryonic cells but join in lymphocytes. This is an obvious directional change of a structural gene during the development. Other cases include gene conversion (when a recessive allele converges on its dominant alternative) as well as isozymic shifts associated with cell differentiation as in lactate dehydrogenase (Markert, 1965; Kolombet, 1977; Frenkel & Hart, 1977).

Although these various pieces of evidence, when taken separately, may seem exceptional to the rule of genome identity in the course of development (which makes allowance for occasional somatic mutations alone), additively they indicate a wholesale directional change in the genome as an integral system paralleling the organismic development.

Fatal to the idea of cloning geniuses is the fact that even plants regenerated from protoplasts of somatic cells differ genetically from those produced from generative cells (Engler & Grogan, 1984). In animals, the latter cells are differentiated quite early to avoid the genomic transformations that occur at the later stages. However, they are not isolated from hormonal signals bounding up all the cells into the integral system of an animal organism and perhaps even capable of inducing the adequate DNA reactions.

GENETIC MEMORY

Inheritance is a function of the genome rather than genes in the same way as cognitive memory is a function of the brain rather than neurons or synaptic processes, although chemical reactions, involving nuclear acids, are instrumental in both cases.

According to the central dogma of classical genetics (slightly modified but not abandoned by molecular geneticists), information goes one way from the genes to their encoded structures, that is, phenotypic, or organismic, features. There is no direct feedback, although indirect feedback is realized in the form of natural selection.

This scheme does not encourage any brain-genome analogues, for neuronal memory is viewed as a direct processing and storage of the incoming information. But since the brain keeps the previously received information in the form of images or concepts, any new experience would inevitably interfere with this stored experience acting as a trigger for the corresponding pre-image or preconceit. A discrepancy between the new experience and its preconception is then corrected either by natural selection (as a mechanism of behavioural adaptation in lower organisms) or by an analytical adjustment (in higher organisms).

In this way, neuronal memory is not unlike the genetic system which stores previous phenotypic experience, is responsive to morphogenic stimuli and is corrected in respect to new experiences by natural selection alone or, according to unorthodox views, in association with a self-correcting process. Similarity may even be more evident in the case of subconscious memory producing dream images but not, or not readily, accessible to an analytical adjustment.

The problem in these comparisons is whether a genetic system stores information as composite images, like the brain does, or as a succession of single gene events on the computer principle. As the Gestalt model of neuronal memory is not a product of individual neuron studies, so genetic memory as a system is not conceivable at the molecular level. Morphology as a product of the total genome can be more instructive.

Elsewhere I have described as retroconvergence a phenomenon of plant morphology involving a composite organ (e.g., the entire leaf formed of marginally fused leaflets) converging on its constituent simple organs (leaflets in this example) to the extent that they become practically indistinguishable. Not only the general outlines of the composite leaf conform to those of a leaflet, but also the venation pattern gets quite alike. There can be several rounds of such a retroconvergence (Krassilov, 1994). While it is very unlikely that retroconvergence might have any adaptive significance, a more plausible explanation appears to be that a genetic system can hold an image and even restore it from the much altered elements. This can be taken as evidence of the genome acting brain-like rather than computer-like.

We can then proceed with our neuronal memory - genetic memory analogues.

In both cases, memorizing is actually a correction of preconceived images. If the discrepancy between a previously imprinted image and its phenotypic realization is conferred by an internal or environmental factor, the genetic system tends to reduce it by correcting the image either on the basis of the available genetic variation or by restructuring its elements. Thus, while a phenotypic modification is sustained epigenetically, a genetic system may undergo a conformational change ever closer approaching the modified image and eventually assimilating it.

This is a general model the technical aspects of which are presently not clearer than our understanding of the imprinting process in the brain. It is obvious, however, that in both cases we deal with learning processes.

GENETIC LEARNING

Functional links between neuronal and genetic learning are evident in the case of predisposition. Incidentally, imprinting, an image-learning that evades conscious memory, is based on a genetic predisposition. It is well-known that children are subconsciously predisposed to language acquisition in contact with language users. Speaking is thus intermediate between walking, learned genetically, and reading, requiring a conscious learning.

Experiments with "enriched" rats placed in artificially complicated environments requiring learning have shown a significant increase in the RNA to DNA ratio in brain cells pointing to an enhanced gene activity (Wallace, 1974; Kazakhashwili, 1974). While certain neuronal pathways are "grooved" (as Freud put it) in learning, a parallel "grooving" may occur in the genetic system.

In the **gene use-disuse model**, I have suggested (Krassilov, 1986) a mechanism based on an interaction of the gene-decoding activity (transcription) with gene reproduction (replication). More actively transcribed genes also replicate faster, and so their expression might be enhanced. Furthermore, with the higher replication rates (which are analogous to developmental accelerations at the organismic level) some repeated spacer elements between the regulatory and functional blocks of a gene can be deleted (underreplicated) so that this accelerated gene would be more readily turned on at a lower level of the activation signal.

A morphological model linking an intensified functioning with an earlier development (the loss of a function with a retarded development - Mehnert, 1898) is equivalent to, and perhaps derivable from, the gene use-disuse model.

Complementary to the latter is the compensation model, stating that a deficiency in a gene product impels an adequate increase in this gene dose and/or amplification of the gene itself. The model is grounded on the well-known mechanisms of dosage compensation (the deficit of the X-linked gene products in males compensated by the doubled transcriptional activity) and magnification (notably restoring a normal synthesis of ribosomal RNA in case of a rDNA deficiency). A regulatory compensation may occur also in case of a deficit caused by an increasing demand for a gene product eventually leading to this gene's amplification.

Actually, adaptation to a special chemical environment in microorganisms is conferred by amplification of the respective genes. Inderlied & Mortlock (1977) have shown that, in *Klebsiella*, xylotol stimulates a selective duplication of gene coding for ribitol dehydrogenase promoting a faster growth on this substrate. Similarly, in *Proteus mirabilis*, a selective amplification of the genes conferring antibiotic resistance is inducible by the respective antibiotics (Perlman & Strickgold, 1977).

The **repetitive DNA shift - heterochrony model** is based on the abundant evidence of divergence in the timing of developmental events between local populations, races and closely related species which differ also in the amount and/or pattern of repetitive DNA (Bernardi, 1976; Mukai & Cockerham, 1977 and some other publications cited in Krassilov, 1980).

Even when next to nothing was known of the molecular gene structure, Huxley (1942) assumed the existence of "rate genes" responsible for the timing of developmental events and, in particular, for the allometric proportions of growth, a change in which might mediate any large-scale morphological transformations. This important topic has been further advanced by Rensch (1954), Schmalhausen (1968) and, more recently, Romer (1972), Loevtrup (1974) and Gould (1977). Although "rate genes" as such are unknown, it is conceivable that interspersed repetitive DNA is involved in timing the genetic activity as discussed in the preceding chapter, so that changes in the fine structure of interspersed repetitive DNA would result in heterochrony, an important and widespread mode of morphological innovation.

Let us look back at the ecosystem evolution trends and the goals they set forth before the coherently or non-coherently evolving populations. In the first case, the traits most essential for an efficient utilization of a selected ecological niche evolve rapidly, the rest dragging behind. The gene use-disuse model seems appropriate for such situations, the used genes evolving to a fuller expression and an earlier replication, the disused ones allowed to mutate randomly, producing the so-called neutral polymorphism which has been brought to light by biochemical methods. Neutral polymorphism was a fashionable line of research, and it was even claimed to facilitate a non-Darwinian evolution, in the late 1960's and in the early 1970's, although its nature was never properly understood. The above explanation accords with neutral polymorphism being higher in the specialized, ecologically coarse-grained, species.

In a non-coherent trend promoting a developmental acceleration we can expect some late genes as well as redundant genetic elements to be dispensed with. The effect may be macromutational, with the time order of genetic and the corresponding morphogenetic events reset. Genomic evolution is thus firmly embedded in ecosystem evolution.

V. PROGRESS

After dealing with "how" and "why" at some length, let us turn now to the "what for" question. To begin with, the legitimacy of "what for" in natural science is questionable in itself, because, for many, it marks the boundary between natural science and metaphysics.

A somewhat different understanding of science and, for that matter, of nature is advanced here. Science is embedded in culture as its component. Humanistic culture is essentially of a "what for" kind. To avoid the "what for" question means to be cut off from this culture.

Moreover, instead of considering humans purposeful, and nature purposeless, I argue for the opposite. Modern humans have lost their sense of purpose, human intervention brings chaos to natural systems which might have been more orderly without man. Science, cut off from the search of a meaningful existence, contributes to the chaos. Instead, it has to bring order by generating the ideas which human existential goals would eventually emerge from.

THE ECOSYSTEM PROGRESS MODEL

In the STE, organisms or their populations are assessed in terms of fitness in turn measured in terms of population growth. Since the most ancient and structurally primitive organisms are fairly well capable of population growth, there is no progress. In a slightly different version of this theory, since there is a succession of living beings in the fossil record, each of the later appearing species must be more fit than or competitively superior to its predecessors. In other words, whatever happens is progress (Huxley, 1942) or at least progression (Simpson, 1953).

Neither of these versions seems plausible. A rapid population growth can hardly be taken as evidence of prosperity. On the contrary, natural populations tend to be redundantly prolific in precarious situations when redundancy alone could buffer them from extinction. In highly unpredictable environments, populations degrade towards the wasteful Niobe strategy (see above). An actual increase in adaptedness is usually associated with lower reproductive rates and less redundant sustainable population densities (the Darwinian fitness equated with a positive population growth seems to have been defined for the Niobe strategists alone, whereas a negative growth is more in line with a progressive trend). As for the second, Panglossian, version of progress, its logic fails in case of the opposite evolutionary tendencies.

In the preceding chapters, we have distinguished two major trends: coherent and non-coherent evolution. Are they both to the good? This can be decided in respect to the general system goals which are sustainability and, by implication, the least entropy production rates. It must be immediately evident that a coherent trend alone conforms to these requirements. The coherently evolving species tend to:

- a more efficient use of trophic resources,
- a coarse-grained adaptive strategy,
- a less redundant reproductive strategy,
- a narrower niche overlap,
- a more efficient reproductive isolation,
- a less competitive and more mutualistic interaction.

Correspondingly, at the ecosystem level:

- the diversity increases both in terms of species richness and the variety of habits (e.g., related to epiphytic life, animal pollination, sociality, etc.),
- the total biomass grows,
- the standing biomass to productivity ratio decreases,
- the productivity to dead mass accumulation ratio drops,
- the recycling of dead mass accelerates to the extent of zero dead mass accumulation,
- the biogeochemical circuits close.

Highly evolved ecosystems are stable but not resilient. When, under destructive environmental impacts, resilience is at stake, the evolutionary tendencies are reversed to:

- a low diversity,
- a low biomass,

- a low biomass to productivity ratio,
- high dead mass accumulation rates,
- open biogeochemical circuits,
- a redundant high-rate reproductive strategy,
- a fine-grained adaptive strategy,
- less distinct species, less efficient intercrossing barriers.

While ecosystems, as here defined, produce living matter from non-living matter, their success or, in a historical perspective, progress can be in most general terms assessed by the life production to death production ratio. A large standing biomass to dead mass accumulation ratio is thus progressive, while a wasteful resource and/or reproductive strategy is regressive.

The turning points from progressive to regressive tendencies are marked by extinctions, notably of dominant climax species (the above climax cut-off), and are known as biosphere catastrophes or crises. Since the biosphere at the present has a manyfold larger biomass as well as a greater diversity than the Proterozoic bacterial mats, we are led to the conclusion that progressive tendencies have prevailed through the history of life, although the evolution of the biosphere has hardly been unidirectional. Periodic mass extinctions suggest that it might have been interrupted and even reversed by major and minor crises.

ORGANISMIC PROGRESS: THE LEARNING MODEL

From an ecosystem point of view, any organismic trait contributing to the sustainability of life is progressive. For instance, parental care is progressive while a precocious development, although advantageous in precarious situations, is regressive. Even without military skill a battle can be won at the expense of heavy losses; yet, as a rule, a more skilled and technically equipped army eventually takes over. Sustainability can be assisted by a hard shell or internalization of vital functions, such as conception, though a more universal and open-ended method is learning, basically in the form of perceiving, processing and storing information which provides for the self-preservation of living matter. Not only learning is adaptive (for, as it was said, to know is to be prepared) but also adaptation is, in fact, learning.

Adaptability is a universal trait of living beings all of which are thereof inheritably capable of learning. In primitive organisms, genetic memory is the only device for learning which is facilitated by natural selection. Up to a certain stage, an evolutionary progress manifests itself in the ever increasing capacity of genetic memory achieved by an adequate increase in the size and structural complexity of the genomes. Yet genetic memory alone is not enough for a flexible adaptation to a more complex environment, while memorizing by means of natural selection is too costly. Thus, further progress is attained with neuronal memory intervening as a mediator between life experience and genetic memory.

Since neuronal memory is built upon genetic memory, there must be a close structural and functional affinity between them. Ideally, an adaptive novelty has to be assessed at the level of neuronal memory before coming to fixation in genetic memory which in turn enriches neuronal memory. There should be intermediate situations in which both kinds of memories act as complementary, like in the acquisition of language in children. Linguists state that babies are born predisposed to acquiring a language as they are predisposed to walking. Yet, although it seems no more necessary to teach them to talk than it is to teach them to walk, they would never learn to speak were they not reared in a language-using environment (see Chomsky, 1972). Birds are similarly predisposed to singing, but with a stronger genetic component, for when reared in isolation they are still capable of producing an abbreviated version of their species-specific song.

A technical aspect of the neuronal memory - genetic memory circuit is obscure at the moment. I have suggested in the preceding chapters that DNA reactions in the synapses involved in long-term memory might encure adequate nuclear DNA reactions perhaps excitated by hormone-mediated nervous signals.

Yet, whatever the mechanism, the neuronal-genetic positive feedback loop might have greatly increased the rates of evolution. Actually, with the advent of neuronal learning (at the level of cephalopod mollusks, about 500 m years ago), evolution has ascended a more productive stage: transient adaptation - a modification not entering the genetic memory - has become possible. In many cases, modification was enough for sheltering the organisms from the censorship of natural selection. Furthermore, neuronal learning is a selection of information, while genetic learning is a selection of information carriers. In the neuronal-genetic learning circuit, both processes are active, yet in the course of progressive evolution their relative contribution shifted in the direction of the former.

With a less stringent selection, more individual variation in learning abilities could be afforded by natural populations, thereof increasing an individual component of adaptation. While only similar organisms compete, individuation can be conceived of as an anti-selectional trend.

FROM NON-SELECTION TO ANTI-SELECTION

In essence, the STE describes a single model in which the initial variation is altered by natural selection in such a way that fitness increases. It is assumed that the more selection the better. Here evolution is conceived of as progressing from non-selective elimination to non-selective coexistence as a systemic goal.

For a panselectionist, any evolutionary trend results from selection of a kind. If there were opposite trends, then two different kinds of selection should be at work. Suppose there is no selection - would there be a trend? The STE answer will be "no," because neither mutation alone nor gene drift alone can sustain a trend. What I have described above as coherent vs. non-coherent evolution may resemble *K*-selection and *r*-selection as denoted by MacArthur & Wilson (1967). In particular, according to the latter concept, the Niobe strategy may seem brought about by *r*-selection. However, like *K* and *r* symbols, these kinds of selection are abstract notions having no reference to any ecosystem reality.

This statement might have seemed less paradoxical had the meaning of the major evolutionary achievements been properly assessed. As it were, they have been evaluated from a viewpoint of the panselectionist paradigm alone. For instance, sexual reproduction has been conceived of as a means of increasing variation (by recombination) in purpose to provide more material for natural selection rendering it more efficient. Far from that, sexual reproduction mitigates the effects of deleterious mutations the heterozygous carriers of which may escape from selection, thus rendering it less effective.

These considerations have been put forth in the **anti-selectional sex model** (Krassilov, 1986) according to which a major function of sexual reproduction is to mitigate selection by compensating the genetic defects through recombinations, with meiotic repair as perhaps an additional advantage. One can argue that sex has brought with it sexual selection which, when superimposed on natural selection, has contributed to a pan-selective environment. However, the concept of sexual selection conceived of as yet another - additional - form of natural selection might conceal a profound semantic difference. In natural selection, the organism is always an object, while in sexual selection it assumes a subject role as well as it remains the object of selective assessment. It is then only natural that these types of selection produce widely disparate and often controversial results. Sexually selected traits, such as the peacock tail, can be maladaptive in respect to a non-sexually oriented behaviour. Moreover, a density-dependent sexual selection favouring some aberrant and to all appearances disadvantageous characters (a phenomenon well studied in *Drosophila* flies) may even protect a rare genotype from being winnowed by natural selection, hence in

Human prejudice equating development with growth, and efficiency with standardization, can impel regressive tendencies, especially in highly centralized and rigorously regulated economic systems. This prejudice has been formed and sustained by the millenia of incessant intertribal warfare. Virtually all regressive tendencies are due to militarization, a major entropy-producing factor. Military production is equivalent to dead mass accumulation. It is not regulated by the resource consumption - quality of life feedback loop, thereof rapidly exhausting natural resources (as the ancient Roman fleet consumed Italic forests). Moreover, military preparations encourage redundant population as well as industrial growth at the expense of sustainability, at the same time fostering standardization both of humans and industries.

Since cities have been initially intended for military defence, they are inherently high-rate entropy-producing systems. Cities hardly occupy more than 4% of the land area but they are centres of regressive tendencies spreading all over the globe. In essence, cities are ecosystems with only one living species which has to be adjusted to a technospheric environment by suppressing its natural adaptations. Thus, urban developments impel robotization of humans. In addition, humans serve as the only target for urban pollution or an appreciable part of it they fail to export to rural neighbourhoods.

From the very onset of urban development, cities have launched a warfare against the surrounding, as well as innate human, nature. For the ancient Greeks, the urban culture was symbolized by Apollo, a homosexual and sterile - unless contaminated - deity ever chasing nymphs and satyrs and known also as a street god in Athens, for he was endowed also with the task of keeping the streets in order.

mental goals from growth to sustainability, assisted by demilitarization and deurbanization tendencies, may eventually result in a more congruent technosphere evolution taking into account the biosphere trends and rhythms. With the growing recognition of our debt to nature, technosphere development in relation to the biosphere may turn from parasitic to mutualistic, as is a common case in nature.

FROM CRISIS TO REPAIR

The late appearance of humans on the evolutionary scene makes sense in relation to our progress concept as a goal-oriented development towards a sustainable existence at the minimal level of entropy production. In the above scheme of ecosystem evolution from a non-selective elimination of redundant elements to selection and then to anti-selection, humans lead the way, for humanism is essentially an anti-selectional philosophy. When it is reported that a hurricane has covered a beach with jellyfish and dead fish, killed dozens of birds, stranded several dolphins and wounded a fisherman now safe in hospital, the idea of progress acquires a numerical presentation.

Yet humanism is a speciistic philosophy which has to be reformulated in biospheric terms for the humans to be able to confer their anti-selectional achievements to natural ecosystems.

The present human activities hardly conform with this goal. Modern humans typically tend to reduce biological diversity by a methodical extermination of "harmful species", or "pests", as well as unintentionally, by disturbing natural habitats. We appear to be responsible for the extinction of about 20% of the total plant and animal species diversity, an impact of geological crisis scale. Furthermore, humans have accelerated the rates of ecosystem turnover by enhancing productivity at the expense of standing biomass and structural complexity. This tendency is most evident in deforestation in which primary forests are superseded by the highly productive but structurally primitive kinds of agricultural vegetation or, much inferior in terms of both biomass and diversity, secondary forests. Ruderal species, as a rule, display a wasteful, high-reproductive-rate strategy and confer these regressive tendencies on the natural systems they invade.

Thus, human impacts conform to the low diversity - low biomass to productivity ratio - high turnover rate - high reproductive rate crisis scheme described above.

However, for humans this scheme may not be the final one, for they are evolving away from the population growth - resource exhaustion negative feedback regulation inherited from their initial pioneer status.

The first human species appeared about 2 Ma as a minor component of what might have been a transitional forest/savanna environment. Until 1 Ma, humans remained numerically subordinate to the closely related group of Australopithecine primates. With the onset of continental glaciations, tropical ecosystems became destabilized by large-scale climatic fluctuations. In them the climax cut-off events could have brought about the extinction of the Astralopithecine browsers and the rise of human pioneer grazers which set out upon the road of ecological expansion. Henceforth they acquired a typical non-coherent fine-grained - high reproduction rate strategy to which they remained faithful until very recently.

VI. METAECOLOGY AND METAEVOLUTION

In the first chapter of the Old Testament (O.T.), creation was described as having been set on by verbal orders. In the second chapter, it was depicted as manual. While technically this dualism might have resulted from joining the different versions of the pre-11th century BC documents, symbolically it meant that two worlds had actually been created simultaneously: one of words, and the other of clay. Characteristically, the creator was pleased with the first one and disappointed with the second. From this point on, words and clay have been used as an alternative though not quite adequate stuff for creating worlds.

Man's special place in nature may be due to his dual - physical and metaphysical - existence. Human ecology pertains to the physical objects constituting our immediate and global environments. Another part of human environment consists of, in a physical sense, non-existing objects. These can be phantasms, art creations or real but no longer living people, such as our late relatives or great novelists. While the latter are objects of our cultural environment, the former not necessarily belong in culture. Thus, **metaecology** is a human perception of spiritual objects, while culture is the part in it that is shared by a human community. Although there are intermediaries, such as physical objects transformed into metaphysical symbols or metaphysical figures perceived as physical, these environments are, at least in modern humans, rather sharply separated from each other.

We define **ecosystems** as life-sustaining biogeochemical non-living matter - living matter - dead matter circuits. In the same way, **metaecosystems** are spiritual life-sustaining physical matter - non-physical matter - the latter's physical embodiment circuits. Inasmuch as metaecosystems borrow material from and return it to ecosystems, they are relevant to physical life. Yet they reflect physical life no closer than plants reflect their soil.

The origin of metaecosystems is a poorly studied matter. The following **internal identifier model** is totally deductive, based on ecosystem analogues. In evolution, there is a tendency to internalize all vital organismic functions and processes, such as conception or early development. Since, along with individuation and the increasing significance of an individual life experience, the maintenance of identity became all-important, it was internalized. In other words, while for primitive organisms an outside identity by *me-thing* relations was enough, for the more advanced creatures and, especially, for humans, it had to be supplemented by a more reliable inside identity through *me-me* relations. The cost of it was the duality of inside/outside self perceptions and alienation of the outer self perceived as an object of the outer world (which can be hated or even killed). Thus, a new system has appeared for sustaining the self-identity, and it formed the relevant structures, notably self-symbols and symbolic languages.

The inner identifier is symbolically represented as soul. It is attempted to give it external life in the form of totem, deity or other spirits. As well as in ecosystems, metaecosystem evolution can be coherent, leading to differentiation of functions and non-competitive coexistence of the internal and external egos. Alternatively, it can be non-coherent, leading to constant suffering which is sometimes conceived of as inseparable from spiritual life.

In comparison with natural ecosystems, metaecosystems are quite recent. But, because of their much faster evolution, their origins seem even more remote and obscure than those of ecosystems. Moreover, for ecosystems we have a more diverse - palaeontological, embryological, genetic, etc. - and much more reliable evidence. Although metaecosystems are here considered as fairly autonomous, some inferences on their evolution can be drawn from the ecosystem evolution theory.

A crucial point in the latter is parallelism of all developing systems, and metaecosystems may be no *a priori* exception. I have argued above that a system starts with a process then involving and moulding suitable structures. The most universal process in biological systems is learning, of which adaptation, genetic inheritance, modification, imprinting and conscious experience are interrelated forms. Inasmuch as these forms of learning relate to the organism - external environment interaction, they are ecosystemic. Metaecological processes relate to an internalized environment, therefore they can be defined as self-learning. Structures involved in self-learning are self-symbols conveyed by special symbolic languages.

While a digression to psychoanalytical, linguistic and psycholinguistic problems may take us too far afield, it is necessary to briefly comment on human language as the stuff which the metaenvironment is made of. Insofar as all communication systems are habitually referred to as languages, human language may appear as one of the many, differing from, e.g., bee language in its far greater creativity alone. However, bee language is primarily a sign language pertaining to external objects, while human language, even in its non-glossal pantomimic and pictorial forms, is primarily symbolic, conveying phenomena of the inner life.

At the same time, signs and symbols intermingle as a result of reciprocal substitutions. The following example would illustrate this in a simplified form. Seyfarth et al. (1980) have observed that monkeys emit different alarm calls at the approach of a leopard, eagle or snake (characteristically, young animals sometimes give false alarms), thus being capable of semantic communication. Extending the above argument, we may note that, as a vocal expression of fear, these calls are symbolic. False alarm calls show that vocal presentation is assisted by the pictorial symbol of an imaginary predator as a cause of fear. If a predator approaching from outside matches the picture, the calls refer to it, thus being used as signs.

It can be noticed also that lower primate perception is essentialistic: fear is the essence of a leopard, and the respective sign conveys it.

Humans show further elaboration of this scheme. Essences, conceivable as "me-thing" units (Kohut, 1971), are conveyed by more variable calls. Moreover, in humans there could have been several rounds of superposition and substitution of signs and symbols in which pre-human semiotics (still present in empathy) has been almost consumed by the later symbolism.

TWINS

Jacob fled from his brother Essau and, coming back, crossed a river and, in doing so, fought somebody who broke his hip and gave him a new name. After that he could join his brother.

Frazer (1923) interpreted this apparently irrelevant episode as a remnant of the pagan mythology where heroes, when crossing rivers, were often compelled to fight river gods. Indeed, British commonsensical theories are always impressive. However, crossing a river (paramita of the Buddhists) - be it Styx, Ganges or Jabbok - is a symbol of death common to virtually all ancient peoples, while renaming is a no less common symbol of rebirth. Of course, Jacob and Essau were not the first twins that appeared in the ancient literature.

In the Egyptian tales all characters are in duplicate. It is mentioned in the Text of Pyramids that, in dying, the twins have to be separated. In the Greek Dioscuri pair, one of the twins is mortal, the other immortal. When Castor had to die, Pollux shared his immortality with him so that they would not part with each other. As in reality, mythic twins are either identical or mirror images of each other. Mythology abounds in the mirror twin conflicts, such as the Jacob - Essau story as well as, in a more deadly version, the Cain - Abel story; their births immediately following each other, they are twins of the ancient tradition rather than sibs of the modern O.T. reading. Moreover, Jehovah is said to have conceived man as his own image, that is, twin. The Jehovah - Adam controversy is then an incident of the mirror twin conflicts.

Biblical patriarches had children both by wives and concubines and, when born simultaneously, the kids were considered as half-twins. Sons by concubines appeared as natural helpers to their legitimate half-twins, and in this way the helper theme crept in the twin theme. Incidentally, Jehovah conceived Eve as a "helper" to Adam.

However, the half-twin relationships often developed upon the twin conflict scenario. St. Paul, who made explicit the symbolic meaning of such stories, complained that, like in the older times, in his days the children of flesh prosecuted the children of spirit. In the later literature, he was echoed by Calderon, Shakespeare, Schiller and a number of lesser authors.

In heterosexual pairs, twin conflicts are constantly associated with incest. In the oriental story of Yama and Yima, the incest theme is fairly explicit. These primordial twins gave birth to mankind by sinfully infringing the incest taboo. Adam and Eve, made of the same material, are twins as well, and by this reason not allowed to mate. In their case, however, incest is disguised as the obscure sin of sharing an apple.

Such euphemisms are characteristic also of other O.T. stories, such as The Song of Songs, a paraphrase of the Babylonian story in which the Moon goddess followed her lover, the Tempest god, in the underworld and was raped by the wards. In the Shulammite story her lover was leaving her for an obscure purpose of lily gathering (which makes sense by association with the asphodel meadows of the underworld). The wards were there, they stripped Shulammite, but the story stops at that.

In addition to being euphemistic, the O.T. stories are realistic in the sense that their characters, Jacob, Essau, have been brought up in contact with sign presentations. Their interaction has set forth the process of double perception in which external phenomena are reconstructed as internal phenomena, that is, translated from a sign language into a symbolic one, and vice versa.

To make such translations possible, there should be a consistent developmental parallelism of the outer and inner structures, ecology and metaecology (literally, translations presuppose a consistent syntactic parallelism of languages). Symbolism is thus based on a developmental parallelism of open systems as manifested in the historical-individual, phylogenetic-ontogenetic, ecosystem evolution - ecological succession parallelisms, all described in the preceding chapters, to which we may add now the parallelism of external and internal occurrences, as anticipated in the Kantian theory of cognition. A common purpose of dream work and art lies in constructing the systems which are viable, i.e. self-sustaining and capable of development in parallel with external life. Waking cognition is doing the same, but in a more sketchy and pragmatic form.

COGNITION AS SELF-INTERROGATION

In our model, self-learning is the process in which a human being is both subject and object of learning, i.e. simultaneously perceives and is perceived. This now automatic but initially laborious double perception is conveyed by twin symbolism which underlies all subsequent dualistic schemes, such as body-soul, body-spirit, mind-soul, ego-superego, man-god, etc.

Since ancient humans seem to have drawn no too clear borders between their ecologies and metaecologies, they might have conceived both parts of the self-learning process as physical realities. In this respect their cognitive efforts might resemble either dream cognition, where a dreamer is witnessing his/her own adventures, or even clinic cases of atavistic mental disorders in modern humans. Mythology attests to a rather painful experience of dualism. Thus, Job was tried by Jehovah, his exigent twin, and subjected to an incessant, passionate torturing and sometimes an apparently inconsistent questioning in which the hippopotamus unexpectedly loomed up as perhaps a half-forgotten Egyptian totem; Job was not allowed to pierce it with his spear, for it had been created with him, hence sexually tabooed.

The Job story, perhaps the most ancient in the O.T., attests to the interrogative style of cognition in which asymmetry of the twins is already quite obvious. Their relations seem to have developed according to the "helper" model (see above), with strong sexual overtones. Much later this self-interrogating cognition was transformed into a cognitive discourse known as Socratic, for Socrates was famous for his ability to sustain the question-answer dialogs of enormous lengths. He seems to have not been through with his questioning in palaestrae but, when back home, he went on interrogating his invisible Daemon whom he claimed to have been associated with from his very childhood. Supposedly the Daemon could answer the most penetrating questions, and he found the proper language which then enabled Socrates to shine in public.

Generally, linguistic abilities seem to depend on such inner conversations, for eloquence seldom associates with talkativeness. In fact, the reverse correlation is more common.

The cognitive function is thus viewed here as an internalized communicative function in relation to the early appearing - and then more acutely felt - dualism of human self-perception. The symbolic language of narcissistic interrogations and discourses became then much more productive than the external sign communication which it eventually assimilated. The dualism of linguistic performance and a more profound role of the inner language are amply evidenced by the syntactic "deep structure" as different from the "surface structures" of a spoken or written language (Chomsky, 1957). Linguistic experiments have revealed that the "surface structures" we actually use in speech are transformations of their embedded "deep structures" (Fodor & Katz, 1964) seemingly never used in external communication.

Language evolution may then be enhanced by the deep structure - surface structure feedback loop. It is conceivable, for instance, that the "intimate" pronouns *I* and *thou* first appeared in inner communication and then surfaced in spoken languages. Children, recapitulating in their linguistic development some salient features of the language history, typically start using personal pronouns at a fairly advanced stage. In adult speech, personal pronouns singulars are still used with some caution, while "thou" in English is almost completely internalized. Moreover, the ungrammatical substitution of "I" by "me" (as in "it is me") may be evidence of a paedomorphic tendency of internalizing "I" as well.

METAECOSYSTEM EVOLUTION

Inasmuch as we appreciate symbolism in art, ancient humans may seem to us poetically more endowed than the modern ones, and the ancient thinking is actually often denoted as mythopoetic. We know from the ecosystem theory that early ecosystems tended to be redundant and overproducing, while their standing biomass to productivity ratio tended to decrease with time. This should be true also for metaecosystems, which must have started with a fairly overproductive stage. Our modern metaphysics is rudimentary in comparison with that of the classical Greeks or Biblical Jews, and the latter were far behind the ancient proto-Arians, Egyptians or Sumers. We are immensely grateful to those who enrich our impoverished metaecosystems with imaginative art creations, perhaps in the same measure as ancient humans might have been grateful to those who reduced the enormous redundancy of their chaotic metaecology by imposing artificial selection.

Humans appeared about 2 Ma, our *Homo sapiens* species about 200 thousand years ago. The true *sapiens* subspecies came into being no more than 40 thousand years ago, while civilization as a highly productive sociocultural system exists for about 5 thousand years, and scarcely over 130 generations separate us from Abraham.

Although modern humans are physically not very different from those who lived 40 thousand or even 200 thousand years ago, and even those remote ancestors made tools, had metaphysical experiences and rudiments of art, one cannot help feeling that at least some distinctions are qualitative rather than quantitative.

For almost 2 m years, the patterns of human evolution were not different - or differed only to a degree - from those of animal pioneer species. In the undersaturated Pleistocene ecosystems, humans might have enjoyed a rather lax natural selection while sexual selection could have been much more efficient. For one thing, early humans might have had polygamous families like in the ecologically similar baboons and, presumably, Australopithecines. Polygamous structures are generally known to reinforce sexual selection as well as hierarchical habits. In addition, humans have developed the round-year sexual activity as a stipulation of the highly evolved Niobe reproductive strategy. Consequently, the early humans were running a high risk of incest impelling complex kin as well as intertribal relationships. Since the neighbouring tribes were compelled to divide their trophic (territorial) resources while sharing their reproductive resources (to avoid incest), they not only had to develop a sophisticated communication system capable of switching militant responses to matrimonial and vice versa, but also to more strictly define themselves in the context of mating taboos and preferences.

In his study of obscene words, Ferenczi (1911) has noted that, of all the words, obscenities have the most immediate effect of action, almost equivalent to a slap in the face. He has further suggested the obscene words somehow retained the effect which all words might have had in some early stage of psychical development when words were experienced "in every sense as things" (Freud, 1913: 56). The following paragraph can explain why this is so.

Insofar as language has developed in relation to a complex network of sex-kinship bonds, "obscenities" might

- in a primordial self-perception based on the *me-world* unity, any external thing could be used as a self-symbol;
- self-presentation was a transfer of self-perception from the inner "me" world to the outer "thee" world which impelled a selection of symbols. During the animalistic period, animals and other natural objects were used in symbolic presentations as belonging to a "thee" world. In contrast, humans could not serve as symbols, for self was not yet separable from other humans;
- pre-historic art was a pictorial language in which hand prints and bison paintings were self-portrait features (see Marshack, 1975);
- in children, attraction to animals and simultaneous attempts at painting are residual symbolic self-presentations;
- hand prints with "amputated" (actually bent) digits, as well as anthropomorphic figures signal an incipient self-insulation by distancing from the other (twin) self as well as from the universe (which, however, remains in possession and serves as a representation of the other self, henceforth asymmetrically gaining in power);
- the use both of pictorial and glossal languages in magic was based on the association of a symbolic representation with possession (while the other self became more eminent, its graphic representation and even nomination was prohibited);

- in addition to dual self-perception, all things used in symbolic self-representations acquired the double meaning of a thing in itself and a thing as the self-symbol later conceived of as the thing's essence;
- the sign language directly inherited from pre-human ancestors might pertain to things, while their essences required a symbolic language.

Even in the early pictorial stage, creativity of the symbolic language was evident, e.g., in such chimeric incest symbols as sphinxes, centaurs, minotaurs, etc., implying the perversion of tabooed mating, either directly, as in the Pasiphae story, or obliquely, as in the case of the Oedipean sphinx or the Biblical snake. At this stage, dream thinking may have been not be too rigidly separated from waking thinking, both enriching primordial metaecosystems with combinatorial images.

With an increased distancing of the self from the other self, and of thing symbols from the things, verbal languages have diverged from image languages. Although for a long time (and partly even now) word thinking retained the structure of image thinking, as evidenced by metaphoric languages, it had a far greater combinatorial potential. And the human brain had to cope with it. Thus, both brain and language evolution must have been accelerated by a positive feedback enhancing.

In parallel with the above developments, waking thinking has diverged from a more conservative dream thinking. The latter is emotionally more charging, for dream images and their triggering words still possess the actuality of things in the waking state characteristic of schizophrenic disorders. Dream thinking thus generates redundant metaecosystem components which, at a comparatively advanced stage of metaevolution, are either non-selectively eliminated by a dream-obliterating mechanism or selectively reduced by the Freudian dream censorship.

Dream obliteration seems fairly recent, for in modern humans its efficiency is still highly variable. Typically, dream memory is better developed in children, while in adults it is retained as a paedomorphic feature. Dream censorship is a thought-selection mechanism (still not fully developed, for dream thoughts are rarely erased beyond retrieval), analogous to but far more idiosyncratic than either logic, a waking thought selection, or grammar, a selection of language structures.

Art creations are often compared to dream creations. In fact, art deliberately restores the thing-image syncretism of a dream, thus arousing cathartic feelings. However, art, at least the classical art, is far advanced over dreams and, for that matter, over the pre-historic art in systematically applying an esthetic selection which is intermediate between logic and dream censorships. In the middle of the XX century, after many centuries of boundless admiration, artists have at least recognized a mortifying effect of esthetic censorship, and this was the end of the classical tradition.

With the advent of selection, metaecosystems (like ecosystems before them) have entered a coherent phase of their evolution, in which they are characterized by a lower redundancy and a more rigid determination of their components. Logic and other metaselection methods are far less wasteful than a non-selective obliteration of the thought, yet they in turn have to be suppressed as entropy-producing factors.

interfere with protoego's biological and social functions. Parity in genetic, social and cultural contributions is unusual, while metaego may even gain from a premature physical death. A "self-sacrifice for an idea" actually seeks to extend the existence of metaego at the expense of protoego.

Both protoego and metaego draw their developmental resources from their immediate environments which in turn depend on global ecological, social and cultural situations. The latter eventually define at what rates and to which extent the innate predispositions would be realized. Incidentally, a comparison of the current investments in teaching the athletics, technologies, natural and social sciences, on one hand, and philosophy, art, religion, on the other, will lead to the conclusion that modern society is aiming at a disproportionately reduced metaego having to cope with a fairly accomplished protoego.

In addition to being infantile, our metaegos are extremely archaic. Three millenia ago, Penelope was not quite serious when she said that her son's sneezing confirmed what had been said; we still, half seriously, partake in this symbolic interpretation of sneezing. Figuratively speaking, while protego is digitizing a computer image, metaego is still watching a magic fire. Needless to say, such a disparity is dangerous.

In the **delegation model**, asymmetry arises from a salient protoego function being delegated to metaego, or vice versa. For early humans there was no sharp distinction between the outer and inner worlds. Ego was all-embracing. In the insulation process, "me" shrank, "thee" expanded. First magic and then freedom were gradually transferred from "me" to "thee" until, in the fatalistic period, protoego remained without magic and, for that matter, without

Then no wonder that duality was generally conceived of as a bad thing. Christian philosophy, as made explicit by gnostics, is primarily based on the idea of unity of the opposites - man and god, virgin and mother, faith and betrayal, death and resurrection, etc. However, in the **tandem enrichment model**, duality is viewed as a potential enhancer of human evolution trending towards the uniqueness of individual existence. A Spanish girl which is a Dulcinea should be more memorable than Don Juan's three thousand Spanish girls, individually scarcely memorable.

THE PANSEXUAL MODELS

Sex might have appeared in the function of supplementing genetic material for an accelerated cell devision. But it soon could have acquired the new functions of meiotic repair and recombinational compensation of genetic defects. As such sex can be conceived of as an anti-selectional device (see Chapter V).

With sex, an entirely new system - interbreeding population - has appeared. Henceforth a new dimension has been added to the ubiquitous trophic and its derivative territorial competition, namely, the competition for reproductive resources. This new kind of selection acts at the molecular, cellular and organismic levels in the form of gene complementarity selection, sperm competition and mate choice (sexual selection proper). Interactions between these multilevel selections might greatly enhance the additive evolution rates.

At the same time, sex impels various forms of mutualistic behaviour ranging from a physical contact between the mating partners adopting, at least temporarily, compatible attitudes to the highly evolved social habits. To facilitate these developments, a number of new traits have been generated and set out upon the tracks of their own evolution.

The basic features of sexual selection are transferred intact up to modern humans. As shown by Charles Darwin and then even more forcefully by Freud, the traits usually thought to be typically human might have developed in response to sexual performances. Here a series of generative models is put forth to account - in most general terms - for the origin of the human traits which are culminations of the trends incipiently defined at the animal level.

The mating choice - individuality trend

In contrast to natural selection, organisms play an active role - being subjects as well as objects - in mate selection which, accordingly, promotes individual variability. Sexual selection can be negatively density-dependent, favouring rare genotypes.

Generally, mating preferences fluctuate between self-similar (to aviod outcrossing) and self-dissimilar mates (to avoid incest, notably in case of a rare genotype advantage). Humans are known to prefer their match or, on the contrary, to be attracted - seemingly perversely, as it were - to their social or moral inferiors. Like an inferior genotype preference in flies, this latter type of mate choice is basically incest-preventive, with more respectable mates identified with parents or other close relatives, thus infringing the innate incest taboo.

The idiosyncrasy of mate choice tends to increase with individual variation in turn contributing to the latter. Thus, a positive feedback-enhancing loop is formed.

The sperm competition - sex enhancing model

In animal couples, the copulation frequency tends to increase either after a temporal separation or a "stolen" copulation with an occasional mate, or even in the presence of other potential mates. This phenomenon has been described recently as "insurance copulation", the meaning of which is for the male to secure the advantage of its own sperm over the sperm of actual or potential rivals.

Human sperm is viable about a week, and the round-year sexual activity might greatly enhance sperm competition in turn fostering sexual activity. Thus, here we also find a positive feedback-enhancing mechanism in action. It is still with us, insofar as modern humans of both sexes still find themselves drawn to their unfaithful spouses. This feeling may be morally frustrating, but there is nothing perverse about it from a viewpoint of sperm competition - insurance copulation expediency.

Human male promiscuity is motivated, as in animals, by a gain in the genetic contribution to the next generation. The female genetic contribution is not in a direct, and it can be even in a reverse, correlation with mating frequencies. However, in primates, female promiscuity can be beneficial in respect to parental care (shared by all potential fathers). Unlike males, promiscuous females seek to secure a limited number of faithful consorts, as in the love triangle which is actually a fairly constant two-husband system, not so much as to increase the number of lovers. Both kinds of motivation might contribute to sex enhancing in humans.

The sex passion - uniqueness model

None of the above sex-enchancing mechanisms can explain the high pitch of sex passion which may seem energetically excessive. At least in mammals, sex passion is apparantly related to the timing of male and female orgasms. It is hypothesized here that in species with heteromorphic sex chromosomes, synchronous orgasm hormonal environments may facilitate XX gametes, while XY gametes may have a competitive advantage with precocious male orgasms. This mechanism compensates a deficit in males, as in war times, by an increased sexual success of too young or too old males with inferior sexual performances. Male births have been actually shown to increase significantly upon a disturbed balance of sexes (Geodakian, 1992).

While sexual performance is highly variable, sex passion may tighten up the couples with congruent performances, ensuring an optimal timing of orgasms as a sex ratio-regulating mechanism. The range of mate choice is thus strongly restricted, and it can be eventually narrowed to a single sex passion-inspiring mate - a unique mating partner.

While sex passion has ascended to sexual love, other variable performances, implicated by the following models, might as well contribute to the mating uniqueness.

Sex origin of semantic communication

In animals as well as in humans, various visual, acoustic and olfactory signals are used in mate search, attraction and appeasing performances. Since reproduction depends on successful performances of this kind, it is essential that all conspecific individuals perceive the meaning of sexual signals in the same way. Moreover, it is essential for a genetic separation of closely related species that non-conspecific individuals would not respond to these signals in the same way. As suggested above, human languages were first used primarily for incest-prohibiting regulations. Therefore people speaking different languages have been treated as of different species. Thus, the species-specific semantics is embedded in sexual behaviour.

In contrast, the non-sexual and, especially, interspecific interactions are based mainly on unconditioned responses which do not imply any meaning-deciphering mechanisms. Therefore, one can assume that semantics as a species-specific system of meanings, and semantic communication in general, have their origins with sex. In this way, sex has greatly facilitated learning and the respective neuronal as well as genetic memories.

The fear-beauty model

Sexual selection occurs in the form of rivalry as well as mate choice. Sexual rivalry impels the development of special weapons for intraspecific combats, which can be useful occassionally, but more often redundant, if not impeding, in interspecific combats. Since killing in rivalry combats would disturb a balanced sex ratio, rivalry is usually reduced to a mere display of weapons or other repelling threats.

In the mate choice, a repelling behaviour, though to some extent admissible, is by and large disadvantageous. It has to switch to its opposite, an attractive behaviour.

Because both forms of sexual selection are intimately interrelated, the tournament weapons and other repelling structures evolved in response to sexual rivalry can be used for sexual attraction, and vice versa. A switch from repulsion to attraction is performed by a change in attitude rather than structure. For example, the males of paradise birds display their plumages to repel rivals, and they do the same to attract females but this time hanging upside down. Thus, they provide a living metaphor of the dialectic relations between fearful and beautiful. Since females find attractive the same features which are repelling to males, there should be an esthetic sexual dimorphism, and not only in birds but also in humans.

Insofar as fearful and beautiful are inherently interchangeable, an esthetic feeling may draw its energy from the more basic and supposedly progenitorial feeling of fear. In Greek mythology, their dialectic unity is embodied in the figure of Apollo, a fearful and beautiful god of art and premature death. Evidence of affinities can be found in any genre, from nursery tales to surrealistic painting.

One can argue that an esthetic feeling pertains to the sense of symmetry, thus being more basic than any sex-derived traits. However, a preference of symmetric patterns has been observed in insects, birds and humans, i.e. species much advanced upon the way of sexual selection. In them, symmetry may be associated with full develop-he tried to explain it, but the moral implications of his theory were grave, with man featuring as the product and heir of a merciless struggle for life.

Had these great men been more sensitive to morality in nature, their teachings might have been quite different. Insofar as morality is a set of self-restrictive prescripts, an aggression-precluding ban of mating behaviour is the first grain of morality. The prescript of not killing sexual rivals comes next, and the incest-precluding ban of not mating with close kin is the third one. They have found their way in all moral teachings.

Incidentally, they constitute three of the ten Commandments, the rest pertaining to more special religious aspects of morality. It may seem natural that humans would have more commandments than animals but, as it will be shown later, the situation appears more complicated.

Hierarchy

It is impossible to live together without ethics, and such rules as taking no more than 10 per cent biomass of the lower trophic level constitute the ecosystem ethics. Needless to say, these rules are unconscious, but such is an appreciable part of our morals as well. Sexual reproduction has evolved a new incentive of living together, bringing with it a set of new rules pertaining, in the first place, to the mating couple which has to develop, at least temporarily, an attitude which can serve as a paradigm of moral coexistence.

Teachers of morality endeavoured to extend love, a sex-derived feeling, to all humanity at the cost of depriving it of its inherent sexual component. Yet they were much ahead of the natural course of extending love stepwise from a mating couple to its progeny to their kin to all conspecific organisms. Also for this extension process to be successful, there should be a positive feedback, i.e. love has to be reciprocated. It is useless to love one's enemy.

Insofar as parental care is known in neither primary nor secondary asexual organisms, we can assume that parental love is sustained by the inertia of sexual love in turn enhanced by the parental love feedback. Consequently, with the extension of parental care in humans there has been a feedback forcing of sexual love.

In the same way as a sexual drive notoriously complicates the parental-filial feelings, parental care overtones are evident in sexual love in both humans and animals. Incidentally, female features in young males (e.g., hen-like combs in young cocks) can mitigate the aggressiveness of adult males. On the other hand, one of the sexes - more often female - can exploit the parental feelings of its partner by behaving like a juvenile. Females are known to adopt a juvenile habit of soliciting food (or its substitutes in humans), an unseemly behaviour in adult males.

Such aftermaths of mating ethics might facilitate a hierarchial structuring ubiquitous though variously developed in all species of gregarious animals. Hierarchy is expressed in social dominance which means, in the first place, a preferential access to sexual resources, sometimes culminating in a copulation monopoly, as in domestic mice. Dominance then extends to all kinds of derivative relations. It confers submissiveness on young and, with an evolving sociality, on subordinate males, the latter even developing rudiments of filial love.

Characteristically, a single male dominance is associated not only with female behavioural paedomorphism, when females imitate youngs, but also with feminization of the subordinate males. In monkeys, subordinate males demonstrate submissiveness by adopting a female copulation posture and even submitting themselves to actual mating by the dominant male (Hinde, 1970). Such submissive copulations, though mostly symbolic, may lead to genetically fixed homosexual predispositions.

Homosexualism is sometimes considered as a special form of altruistic behaviour (see Wilson, 1975). However, in animal as well as human societies all members are, to some extent, altruists, for societies are founded on self-restrictive ethics. Not only social insects, but also many mammal species have "helpers", i.e. the individuals that spare their sexual life for the sake of their kin. A more sophisticated form of helper behaviour has been observed in the chimpanzee where subordinate males can help each other against the dominant male and even overthrow him.

But even a dominant male is altruistic in shouldering most of the defensive combats for the sake of its subdominants. Moreover, in combats between its subordinates, the dominant male usually takes the side of a weaker party acting as an anti-selectional agent (Trivers, 1985).

Thus, altruism can be conceived of as an emergent holistic feature imposed on all the components for the sake of their system sustainability.

We know that sustainability is fortified at a certain level of redundancy, with both non-redundant and over-redundant systems unsustainable. Regulation between these extremes can be most economically implemented by self-elimination of redundant elements, and homosexuality is an instance of it. In humans, homosexuality and other self-eliminating habits, such as, e.g., toxicomania, increase characteristically with the redundancy of urban societies.

Feelings developed by a subordinate male to its/his seniors are a blend of sexual submissiveness and filial love, of which either can prevail, resulting either in a homosexual or a proto-religious drive.

Freud did not need to be embarassed with accusations of pansexuality. Reproduction, the most salient function of life, is inevitably found at the roots of all metaecological phenomena exept those which are death-derived.

PANESCHATOLOGICAL MODELS

It was argued in Chapter III that ageing in multicellular organisms is related to cell senescence in turn consequential to concerted genome alterations, including isozymic shifts, heterochromatization, decreased repair efficiencies and the issuing aneuploidy (notably the loss of sexual chromosomes in ageing females), chromosome breaks and other defects.

Since generative cells are also subjected to these wholesale senescence processes, it is in the interests of the next generation that reproduction ceases at a certain age. This means a genetic death of the ageing individuals and, while they are redundant, their physical death follows after a not very long, but less strictly controlled and therefore highly variable, stretch of time.

voluptuous woman still surviving in some nursery tales. This creature could have quite easily found her way from dream reality to the then not clearly separated waking reality as a symbol of death itself. Northern Arian (or perhaps even pre-Arian) tribes actually perceived death as an old woman getting younger and even attractive with time, who roamed battle-fields seeking for a dying hero to copulate with. In Irish sagas, a hero would often be taught military arts by an enigmatic old woman, presumably Death itself, living in a remote place - the underworld on the assumption that a man had to visit it for acquiring the fighting skills of a hero.

Valkyria is no doubt a later development of the Death woman image. The Greek Alhene, a virginal goddess, would mate with neither dead nor living hero. She is far advanced over the Death woman of the sagas, yet her atavistic battle-inspiring function betrays her Valkyrian affinities. Aphrodite, primarily a love goddess, may seem far remote from any death symbolism. However, the "dite" part of her name is in fact one of the Death woman names sometimes applied also to the Greek-Roman goddess of the underworld.

Transformation of the Death woman into Aphrodite may evidence of a death concept evolution. Death came to be thought of as a gain rather than a loss. The death-rebirth dialectic could be prompted by the Sun or agricultural practices. In any event, there were universal attempts at appeasing death by recognizing its dominant status as a pack leader and the consequent sexual submissiveness.

The death-copulation parallels are evident, notably in Arian mythology. As in animal packs, those individuals which mated with the leader are raised in their social status, so death copulation has endowed mortals with superhuman qualities. The mere idea of superhumans - heroes or gods -

might have had its origins with the death copulation concept. Even in the classical period, heros like Orpheus, Hercules, Theseus, Ulysses or Jesus Christ had to visit the underworld, and those heroic practices were later adopted by Aeneus, Dante, Faust and other Roman, mediaeval and Renaissance heroes. This tradition involved also intellectuals and orators who were suspected in acquiring their abilities from the underworld. Occasionally, a nation superior in military or rhetoric skills was considered as coming from the beyond. Thus, "Hebrew" means one coming across the river (a cosmopolitan ancient symbol of death and resurrection), a name given to invaders by the local Palestinian tribes.

In the classical period, however, not only the ruling clan of gods distanced itself from the underworld but also death itself changed its sex. With Thanatos, eschatology became uninteresting and inconsistent. Sad shadows of dead heroes forever roaming the lily meadows of the underworld were either deprived of consciousness or some of them retained it, or all of them could restore it at will.

Along with these eschatological developments, Hellenic metaphysics gradually declined rendering Greek mythology and Greek art euphemistic and repetitive. Yet these were rich in comparison with the barely existent Judean ones. Christianity had to fertilize these dried sources with eschatological ideas brought in from the north and east.

In a far from precise chronological order, the major eschatological models were as follows:

wishes, there was no freedom. In principle, it was possible to become Buddha in this life, but even Buddha himself achieved nirvana only after his physical death.

Stoics developed much the same model, which came to welcoming death and pretending to be as dead as possible even when alive. Plato in his later works modified the death dominance model, introducing into it a free choice of the next incarnation. With free will appearing in this world, the absolute dominance of the other world came to an end.

The balance model

The idea of this world as a balance keeper between two other worlds was formulated by Plato, but even much before him it had been implicated by the Zoroastrian teaching of the east as well as the Daoistic and related balance models of the east of east.

In the balance model, humans are free to cast their lives to weigh down either the world of goodness or the world of evil. Their lives are thus far more significant than in the preceding model. In effect, the balance model is fairly competitive. It easily penetrated the realms of the mirror image and the death dominance models in the form of the Orphic, Essene, Kumran and other sectarian teachings which gave rise to the present-day major religious and parareligious (notably communistic) metaphysical systems.

Although officially rejected as Manichaean heresy, the balance model is prominent in the writings of St. Augustin and other Christian philosophers who attempted a synthesis of the Greco-Judean Stoicism with the Persian Zoroastrism modified by Neo-Platonics. These components are still not quite blended, with the death dominance model prevailing in the more esoteric circles and the balance model coming forth in the lower Christianity.

In accordance with the balance model, a sex-derived metaecology was counterweighted with a death-derived one. Even phallic gods were opposed with dead gods. Chief deities of death metaecology had a special distinction of being twice dead. Thus, the Nordic Odin was depicted in the sagas as hanged and pierced with a spear, and people were sacrificed to him in that way. Even Jesus Christ was not only crucified, but also, for some obscure reason, spear-pierced by a Roman guard.

Death esthetics was based on a primaeval attractivences of the horrible. Death ethics powerfully enhanced the self-elimination instinct which had appeared in response to social redundancy (see above). The sex-derived moral prescripts, including the universal do-not-kill and do-not-mate-your-kin commandments, were much weakened by the notion of transient existence, and partly because of this human morals sometimes degraded far below the animal level. This is what the Iliad is about. Moreover, the "all of us are mortals, hence we all are the same" logic negated the so laboriously acquired uniqueness of human personality.

Opposition of sex-derived life-sustaining and death-derived destructive forces is a dialectic one, with the phallic god and dead god features blended in a single deity, and sexual dances merged into a dance macabre. Yet local cultures differ in the relative strength of the sex and death forcings counteracting each other. Such differences are reflected in the relative development of local eschatologies rich in barbarians and comparatively poor in the classical Greeks and Jews.

The respective attitudes towards death itself were markedly different. The Greeks considered death at an old age as a special blessing of the gods, while a premature death was a tragedy, as in the case of Achilles. With barbarians it was the other way round - an early death was glorified as the best thing one could achieve in life, and it was actually sought by many barbarians, from Orlando to Byron and further to Hemingway, except that poetic examples can be ambiguous, with local cultural traditions overlapping and reinforcing the universal self-elimination drive.

At any rate, these contrasting death concepts have generated quite dissimilar cultures within the Arian realm, the incipient dichotomy being perhaps related to environmental differences. Temperate forest, the cradle of Nordic barbarians, had an obviously much smaller carrying capacity in comparison with Mediterranean ecosystems which could sustain much larger human (and, for that matter, animal) populations. In effect, the Nordic barbarians, ever redundant, sought a solution to their demographic problems in territorial expansions, encouraging a hideous flirtation with death.

SEX ENRICHED

At many occasions we can see how extremely conservative sex is. Sperm competition passions and security copulations are still with us lurking behind the more respectable motivations. Since sex is a secondary function superimposed on food consumption and excretion, sex organs can be combined with either of these - more often with the latter, but in lower organisms also with the former. Humans still indulge sex in extremely atavistic forms reminiscent of sexuality in lower organisms. Such sexual anomalies are evidently paedomorphic, for the evolution of sex is briefly recapitulated in the course of development - in babies, sexuality is admixed to all the basic sensations, succeeding through a series of oral, anal, urethral and genital phases.

Early humans adopted the pioneer strategy of high reproductive rates which led to the year-round sexual activity in turn instigating sexual competition.

Jealousy is, of course, a fairly ancient feeling going back to sperm competition as an enhancer of the sexual drive. Yet some sociologists link it with a proprietorial drive, pointing out that, as a rule, husbands are jealous, but lovers of married women are not. This apparent anomaly can, however, be explained without any reference to property. In a classical triangle, the husband, irrespective of his personality, is conceived of as the dominant male. Therefore his preferential right to copulation is admitted - at least subconsciously - by the lover, the subdominant male of the triangle. Their respective roles may change immediately with the lover being promoted to the husband status.

Yet the proprietorial drive has added a new dimension to jealousy (as in the "Man of Property"), while metaphysics has raised it to the tragic heights of Othello, who not only secured Desdemone as his wife to make love to, but also intimated to her all the experiences of his adventurous life, thus making her his metaphysical twin. In animals, a dominant male would chase out a rival and then make love to the unfaithful female with double energy (except that in the chimpanzee a female can be occasionally punished by her consorting male for contacting his rival, see Trivers, 1985). In humans, however, the logic of jealousy is distorted, taking a suicidal turn.

At the same time, an idealized sex enhances metaecosystem productivity, for the sake of which sexual restrictions are usually imposed on the ministers of metaecology.

With sex enriched, all sex-derived metaecological phenomena tend to expand over a wider range of ecological phenomena. Thus esthetics, evolving from mating preferences, spreads from the primary sexual attractants to the whole body (including those parts which, like breasts, could hardly be involved in a sexual display but acquired attractiveness by association with intimacy and the issuing sensations of confidence and exclusiveness), and from sexual symbols - mimic, acoustic or transspecific, such as flower offering - to symbolism in general. Inasmuch as we find dancing, music, metaphoric languages or natural landscapes beautiful, we are induced to assume that esthetics has been stepwise elevated over the protoego sexual pragmatics to an idealized sphere of metaego sexuality.

Ethics, arising as a copulation-encouraging attitude, then involves close kins (primarily in the form of non-mating and non-killing prescripts) and eventually all individuals sharing a species-specific sexual symbolism and thereby regarded as conspecific. Insofar as human language has appeared in response to sexual symbolism (see above), human ethics has been restricted to those speaking a common language. Yet human languages have diversified much faster than human bodies resulting in many metaego species whithin a single protoego species. However, the primary symbolism of jestures and caresses is also variable between human races.

It was a great ethical achievement of the humanistic era to extend moral attitudes to all human beings. But the ethical evolution would hopefully not stop at it. The next stage is anticipated by the animal rights movement - incipient transspecific morals - as well as the growing environmental concern and our better understanding of human natural bonds. At this, still far ahead, stage our ethics would embrace the biosphere as a whole system.

At the same time, impersonal all-embracing love can arise from an impersonal bacterial sexuality alone, whereas individuality, primarily related to sexual selection, further evolves at the metaecological level as a stipulation of eternal love. Its further development is impelled by death enrichment.

DEATH ENRICHED

The sensation of duality has brought with it the awareness of immortality superimposed on death awareness. It was assumed that death is partial, affecting one of the twins, while the other one - preferentially metaego as the keeper of primary identity (contrasted with the identity from outside, see Lichtenstein, 1977) - is immortal, as in the Dioscuri. Then the immortal twin, again as in the Dioscuri, may confer a part of its immortality on the mortal one.

As a logical outcome, the salvation of protoego was conceived of as its merging with or even dissolving in metaego or its god-like impersonations. It was concluded that the less there remained of protoego the better. Insofar as the religious teachings are primarily teachings of immortality, they or most of them proclaim a reduction of protoego as the best life strategy. It does not seem wise, however, to put all eggs in one basket.

Oscar Wilde said that those who lived more than one life would die more than one death. Generative cells lose their identity, dying as separate living entities during copulation. The mother-child superorganism dies with birth, leaving the dim womb memories of a lost paradise. Cells, notably brain cells and even tissues, die in the course of organismic development. Sexual maturation was conceived of as death and rebirth, and not without reason, for it is accompanied by a wholesale hormonal restructuring, symbolized by initiation rituals.

Insofar as biological existence aims at reproduction, it makes sense within the scope of an optimal reproductive period, the end of which is conceived of as the death of protoego, as in the case of Jesus of Nazareth at 33 or of Buddha at 35. In reality, many heroes and geniuses died, killed themselves or got themselves killed in duels or otherwise at approximately that age. Ironically, they constituted the last redundant part of a post-optimal male redundancy.

Our concept of evolutionary progress maintains that killing must be replaced by the less wasteful methods of reducing the male redundancy. It appears that both the protoego and, especially, metaego productivity can be protracted far beyond the limits of a selectionally fixed optimal period of sexuality. In natural human populations, restrictions of the latter have a stabilizing effect, for most mutations are transmitted with male gametes. In modern semi-natural humans, variability is beneficial rather than disadvantageous. With stabilizing selection losing its grasp, the time limits of optimal sexuality become more flexible, and the metaego productivity varies with them.

Moreover, with an increasing rigidity of social systems, the realization of metaego productions is much delayed (in case of the Darwinian theory, the major ideas came at thirty but their extrication was postponed until fifty). In effect, ageing men are no longer (not necessarily) redundant.

Thus, both protoego and metaego variability adds to human individuality. From a viewpoint of system evolution, individuation comes forth as a redundancy-reducing strategy.

With individuation, more possibilities have opened for life after organismic death. All the sexually reproducing organisms live after death in the genes they transmit to the next generation(s). In other words, they all live in genetic memory. Higher organisms live also in the form of traces they leave in neuronal memory which was at first much shorter than the genetic one. In humans, neuronal memory has been much protracted by the social and cultural systems built upon it.

Thus, there is more than one life and more than one death. Potential immortality has been achieved first at the genetic and then at the neuronal and sociocultural levels. For humans, genetic immortality is not enough, for, insofar as their individuality is essentially polygenic, it cannot be transmitted intact through the recombinations of genes. More individuality can be in fact transmitted culturally, acheiving practical immortality in long-lasting cultures. The end of a cultural tradition would then mean the death of all the individuals contributing to it.

What the metaphysical death theory hence comes to, is that immortality and the quality of life after death are determined by the sum of non-redundant (that is, bearing a personal touch) biological, social and cultural achievements. Human progress is thus manifested in the interrelated processes of individuation, making humans and their productions non-redundant, and a concomitant increase in the brain and sociocultural system capacities ever providing more room for individual contributions and sustaining more post-mortem lives.

DETERMINATION

Our inability to foresee our future has been regarded as a shortcoming or a special blessing of gods, depending on the currently prevalent existential philosophy. Yet our lives are incessant prediction-fulfilment (or non-fulfilment) processes. For long-term forecasts, we apply to oracles, science or philosophy. Their forecasts pertain to particular systems, while their precision depends on how far the system is determined and how far it is understood, the former being an objective, the latter a subjective, limitation. Apparently, oracles are better positioned than scientists, for they deal with rigidly determined systems they claim a thorough understanding of.

In the magic period, a prevailing world view was indeterministic, the course of events being changeable at will or rather by a clash of wills. In the fatalistic period, it was manifestly deterministic, with all events decided beforehand. Yet, insofar as fate was concealed from the mortals, free will could be manifested in seeking to discover it by the trial-and-error method. This is what Ulysses was systematically doing despite the protests of his more timid or less curious companions. In other words, the world system was thought of to have been objectively determined, and the freedom in it was due to a subjective factor (incomplete understanding) alone.

treaty between Abraham and Jehovah negotiating as nearly equal parties (Abraham resented Jehovah's decision to destroy Sodom and Homorrah and eventually induced him to refrain from indiscriminate homicidal practices) and coming, through a series of subsequent treaties, to the derogatory humility and deprication of human free will in favour of Jehovah's.

Humans are thus determined by all the systems which they take part in, their freedom, paradoxically as it may seem, coming from overdetermination.

By overdetermination, Freud denoted a multiple causation with determinants arising from different systems (see Litowitz, 1978). This term is used here in a somewhat broader sense implying a concerted determination by ecological and metaecological systems. Inasmuch as various determinants balance each other, overdetermination may open a new way to freedom.

Free will models

As it was discussed above, free will concepts are closely related to determination ones. According to the fatalistic model (including the Homerian and Spinosan variants), freedom consists of a voluntary submission to determination, i.e. the system necessity. Biological examples show, however, that a rigid determination leads to overspecialization and the loss of evolutionary potentials. Had the early humans adopted a fatalistic strategy, they might have shared the fate of the Australopithecines.

In contrast, the escapist model, of which the Buddhist and existentialistic concepts are examples, comes to

The horizontal system relation

The major existential systems - natural, social and metaphysical - are traditionally thought of as being placed vertically, one above the other, as God/Man/Nature. With this arrangement it is inevitable that one of the systems, preferentially the top one, would suppress the other(s), thus endangering the free will that comes with overdetermination. Thus, urban society suppresses nature, while metaphysical systems tend to put down sexual and social life.

In contradiction to the widely held belief that morality is generated at the metaphysical level alone, it has been argued above that the fundamental moral prescripts of not mating with and not killing one's kin must have appeared in the natural system as an outcome of sexual selection. In modern humans, these had to be confirmed at the metaphysical level to prevent metaego from taking a homicidal turn.

Symbolically, homicide was initiated by Cain killing his twin brother Abel because of a metaphysical difference. It must be recalled once again that it was Abraham, stipulating for the homicide ban, who taught Jehovah morality, not the other way round.

Metaphysical moral standards, such as the love-thy-enemies commandement, are deliberately raised beyond the reach of an average human being, thus setting in inferiority complex in turn generating a self-derogatory drive. Whatever the outward goals, a system aims at a complete determination of its members delegating their free will to the higher powers.

Paradoxically, the further one advances along the path of determination, the more remote the declared goals are, for they - be it universal love or the extermination of properietory instincts - demand a mobilization of all free will resources which diminish with advance.

A symbolic meaning of Jesus Christ declaring himself a brother rather than the father of humans lies in the vertical God/Man/Nature hierarchy being transformed into the horizontal Nature-Man-God relationships. He seems to have endeavoured by that one bold step to set in a parallel transformation of the vertical social psychology that forces the people to elbow their way up, into universal love, a horizontal relation not to be confused with the vertical relations of submissiveness and self-deprication.

Uniqueness

Human uniqueness is an outcome of the self-enrichment process setting out with sexual love (Chapter V), a "horizontal" link in the mating pair system.

A positive feedback has been established between self-enrichment and the emergent systems built upon it, such as the self-identification system. Self-identification, or primary identity (Lichtenstein, 1977), is a life-long process sustained by the perpetual interaction in the protoego-metaego system. I know the little boy wishing to dance at a festival was me because other people say so, but I do not need such an evidence from outside to identify myself with the little boy running in the meadows imagining himself Bamby deer, for there is a reliable metaego evidence. Duality is potentially self-enriching, for overdetermination is based on it and is further advanced with complication of the interior system.

This optimal situation is symbolized by the Dioscuri, the mutually enriching twins. There are, however, numerous examples of mutually depricating twins, such as Jacob and Essau, Jekyll and Hyde, Dorian Gray and his Picture. In the latter cases, competition, a vertical relationship, prevails over love, a horizontal one.

Evidently, self-enrichment can be either enhanced by the horizontal duality or impeded by the vertical one. Insofar as social and metaphysical systems are projections of the inner duality, the same relations hold there too. Externally, uniqueness is a social phenomenon, for it is possible to be unique only in comparison with other people. Furthermore, the external - social or metaphysical - projections of a unique personality are not like any other, i.e. creative. Actually, creativity may serve as a measure of uniqueness, a system parameter opposite to redundancy.

As it was argued in Chapter V, in the course of evolution, redundancy is reduced first by non-selective elimination, in which rare individuals have statistically very little chance to survive, and then by selection which typically sustains the norm against occasional deviations. At this stage, unique individuals are eliminated, if not by crucification, then by less dramatic means, such as standard education, mass culture, ritualization of metaphysics, and delegation of individual free wills to social or metaphysical powers.

Social revolutions have been committed in a desperate search of free will popularly identified with equal opportunities. They have led from a "layered" competition of the caste and class societies to a "non-layered" (free) competition typical of the modern democracies. But competition in whatever form generates a hierarchy, a vertical structure reinforcing both superiority and inferiority drives. As long as the human existential goals are arranged along this vertical axis, there will be an irreducible redundancy at both ends of it. With people elbowing their way up to the top or seeking to be as anyone else, an egalitarian society is hardly attainable.

Personal uniqueness does not mean independence from society. On the contrary, transient unique qualities and the creativity which goes with them make sense only if they are conferred on society and preserved in culture, the comparatively long-lasting systems. At the same time, uniqueness is an alternative to fitness as the goal of a non-selective system development.

Since overlapping individuals alone are involved in competition and since competition is reduced with a narrowing overlap, uniqueness may lay the foundation of a self-enriching egalitarian social system.

Due to an enormous complexity of the human genome and the great extent of recombinations, each human individual is unique at the genetical level. For the uniqueness to be extended to the ecological and meta-ecological levels, it has, in the first place, to be protected from the unifying and depricating effects of absorbing social or metaphysical involvements. To mobilize all the resources of overdetermination stored in the duality of human existence, both protoego and metaego must get an equal footing in human life. Their diachronous developments have to be fully explored as an internal phenomenon underlying the external periodicities of sexual, social and metaphysical activities, one typically lagging behind the other.

Incidentally, a metaphysical engagement peaking between sexual maturation and the optimal reproductive period may turn suicidal, as in Werter, or produce homunculi, as in Wagner. Instead, it can provide for an interior complexity, thus laying the foundation for successive bouts of biological and social productivity, as in Faust. Advancements in the art of living are due to the latter strategy, impelling long-lasting contributions to all spheres of life that does not end with organismic death.

An ethical overdetermination means that moral prescripts emerge in different systems as an outcome of their evolution. The innate morality often ascribed to inspiration is, in fact, of biological origin. Both ecosystem and metaecosystem developments contribute to an ethical enrichment and are in turn embraced by an extended biospheric ethics. Overdetermination thus opens the way to ethical creativity, hitherto a prerogative of very singular persons alone.

VII. CONCLUDING REMARKS

When expounding their ethical teachings, ancient moralists used to start with the creation of the Universe. They somehow felt that creation and subsequent historical events were relevant to what they had to say. And right they were, since all the way up from tectonics to ethics we deal with systems superimposed on the earlier arriving systems, inheriting from them, developing structures in parallel with each other and thus forming the basis of a unity of science. The general system theory defines progressive evolution of a few ecosystem parameters, such as biomass to productivity to dead mass ratios. But to decrease the latter in accordance with the entropy law, an ecosystem must increase its diversity by suppressing competition and promoting individual distinctions. All other evolutionary patterns are derivable from this general tendency. For what comes up in one field is bound, in the long run, to be relevant to all the others. Incidentally, ethics appears as a domestic function providing for the coherence of a system. In a more habitual sense, as a self-restrictive attitude, ethics promotes all kinds of co-operation, if but as transient as a single copulation event. Organismic ethics thus appears with sexual reproduction as a special attitude for mating then spreading to other kinds of co-operative behaviour (often exploiting the inertia of a sexual drive, as in the parent-offspring ethics) and to the ever more comprehensive systems - demes, families, societies, species and, perspectively, interspecific entities up to the biosphere as a whole.

It was a crude mistake of grave consequence that ethics was thought of as arriving with and for humans alone. The duality of human nature was interpreted in such a way that its heritable biological component was totally unethical, with ethics confined to an acquired spiritual component alone. Accordingly, humans were considered as pitiable creatures having to ever drag along their spiteful biological heritage. Their duality was ascribed to some primordial mistake made by Sophia of Gnostics, Pandora, Eve or another irresponsible female or else by some fiendish influence. Perfection was identified with wholeness as a goal of human existence.

The Darwinian theory made an important contribution to this line of thought. According to it, man emerged from a merciless struggle for life, therefore, inherently even worse than one could imagine. It was suggested that man had to be left to his immoral nature, but this was a minority view. The majority, endowed with Christian perfectibilism multiplied by Darwinian selectionism, entered the XX century with the firm conviction that man had to be radically improved. There were some residual controversies about the methods - test tubes, gas chambers or concentration camps - but eventually the two latter were widely applied as practically more efficient. It has repeatedly been proven, there is no mightier source of evil than the desire to improve human nature.

As well as human nature, the surrounding nature has been treated as an enemy to be conquered. We feel it now that perhaps this was not the best option in our environmental policy, but we still fail to admit the intimate interrelations and inevitable adequacy of approach to the outer and inner nature.

It has to be recalled that Adam and Eve had to eat fruits from the tree of knowledge before they broke the inherent ethical commandment forbidding incestuous matings. In the case of the primordial Cain - Abel killing violating the inherent commandments of the species and, above all, kin ethics, the motivation was ritualistic, that is, spiritual rather than biological. It is this kind of acquired immorality that we are dragging along. In social animals, aggression is usually provoked by some communication system failures, that is, by the lack of understanding. In humans, due to their rapid linguistic and ritual divergence, misunderstanding has become habitual resulting in unprecedented intraspecies aggressions. Even on the individual scale, the most aggressive persons are those who fail to properly communicate with other people, thus treating them as of other species; thus, aggressiveness takes the form of xenophobia.

Erosion of the genetically transmitted ethical prescripts had to be compensated by metaphysical or social prescripts, that is, by the fear of god or police, or both combined, e.g., in the Athenian street deities. Fear turns on aggressiveness (or that part of it which could not be successfully readdressed to a xenic target) inside as self-aggression erroneously interpreted as a "death instinct". In an egosystem, one of the twins, more often the acquired metaego, administers the police and prosecutor functions to a natural protoego. It can be also the other way round, but the results are derogatory in both cases. There are no death instincts, but there is a self-eliminating drive which goes with submissiveness or even submissive love.

The Darwinian theory has contributed to the misunderstanding of human nature mainly because it was taken for what it was not, i.e. a general evolutionary theory. It was originally formulated as a special theory of natural selection at the organismic level (with neither genetics nor ecology yet appearing, no other levels could be considered - see Vorontsov, 1980; Nevo, 1983) not addressing the major problems of evolutionary progress, but was then inflated out of all proportions both by proponents and critics. The problems remaining outside the theory were claimed non-existent. But, as Kenneth Pike, a well-known linguist, said on a different occasion, "problems assumed or defined out of existence have a troublesome habit of reappearing".

Natural selection appeared in association with the archaic trial-and-error method of adaptation which, in higher organisms, was replaced by less entropic methods of genetic and neuronal learning. The latter has dramatically increased the value of an individual life experience, making individuals indispensable. Sex, sociality, ethics, etc., have appeared for the protection of individuals from selective elimination, thus decreasing the entropy production rates in supraorganismic systems. With the on-going evolutionary progress of life, less and less of it is given to death. Humans have appeared upon this track of animal evolution and for them it seems natural to continue in the same direction. Conceived of as the keeper of a garden and potentially capable of providing a repair service to the biosphere, man is bestowed with a strong primordial feeling of affinity with the whole world, nothing in it being xenic to him. This feeling, reflected in the ancient art and mythology, may, in the natural course of events sadly distorted by the incessant attempts at salvating man from his natural bondage, give way to a biospheric ethics.

With the existential goals not forced on human nature but determined by the natural course of evolutionary progress, the egosystem, freed from xenophobic aggressiveness as well as from derogatory self-aggression, will become far more productive and then, as St. Paul wrote to the Corinthians, the last enemy - death - will be destroyed.

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