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THE FIRMAMENT OF TIME

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1) difficulty for man to grasp geological eons of TIME.
2) man's effect upon the natural environment. (?)
↳ man's relative minuteness

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MAN is at heart a romantic. He believes in thunder, the destruction of worlds, the voice out of the whirlwind. Perhaps the fact that he himself is now in possession of powers wrenched from the atom's heart has enhanced the appeal of violence in natural events. The human generations are short-lived. We have difficulty in visualizing the age-long processes involved in the upheaval of mountain systems, the advance of continental glaciations or the creation of life. In fact, scarcely two hundred years have passed since a few wary pioneers began to suspect that the earth might be older than the 4004 years B.C. assigned to it by the theologians. At all events, the sale of Velikovsky's *Worlds in Collision* a few years ago was a formidable indication that after the passage of two centuries of scientific endeavor, man in the mass was still enormously susceptible to the appeal of cataclysmic events, however badly sustained from the scientific point of view. It introduced to our modern generation, bored long since with the endless small accretions of scientific truth, the violence and catastrophism in world events which had so impressed our forefathers.

Man has always had two ways of looking at nature, and these two divergent approaches to the world can be observed among modern primitive peoples, as well as being traceable far into the

eons to create the scene at Glen, for example.

primitive past. Man has a belief in seen and unseen nature. He is both pragmatist and mystic. He has been so from the beginning, and it may well be that the quality of his inquiring and perceptive intellect will cause him to remain so till the end.

Primitive man, grossly superstitious though he may be, is also scientist and technologist. He makes tools based upon his empirical observation of the simple forces around him. Man would have vanished long ago if he had been content to exist in the wilderness of his own dreams. Instead he compromised. He accepted a world of reality, a natural, everyday, observable world in which he existed, and whose forces he utilized in order to survive. The other aspect of his mind, the mystical part seeking answers to final questions, clothed this visible world in a shimmering haze of magic. Unseen spirits moved in the wood. Today in our sophistication we smile, but we are not satisfied with the appearances of the phenomenal world around us. We wish to pierce beneath to ask the question, "Why does the universe exist?" We have learned a great deal about secondary causes, about the *how* of things. The why, however, eludes us, and as long as this is the case, we will have a yearning for the marvelous, the explosive event in history. Indeed, so restless is man's intellect that were he to penetrate to the secret of the universe tomorrow, the

likelihood is that he would grow bored on the day after.

A scientist writing around the turn of this century remarked that all of the past generations of men have lived and died in a world of illusions. The unconscious irony in his observation consists in the fact that this man assumed the progress of science to have been so great that a clear vision of the world without illusion was, by his own time, possible. It is needless to add that he wrote before Einstein, before the spread of Freud's doctrines, at a time when Mendel was just about to be rediscovered, and before advances in the study of radioactivity had made their impact—of both illumination and confusion—upon this century.

Certainly science has moved forward. But when science progresses, it often opens vaster mysteries to our gaze. Moreover, science frequently discovers that it must abandon or modify what it once believed. Sometimes it ends by accepting what it has previously scorned. The simplistic idea that science marches undeviatingly down an ever broadening highway can scarcely be sustained by the historian of ideas. As in other human affairs, there may be prejudice, rigidity, timid evasion and sometimes inability to reorient oneself rapidly to drastic changes in world view.

The student of scientific history soon learns that

field supposedly devoid of it. The man who learns how difficult it is to step outside the intellectual climate of his or any age has taken the first step on the road to emancipation, to world citizenship of a high order.

He has learned something of the forces which play upon the supposedly dispassionate mind of the scientist; he has learned how difficult it is to see differently from other men, even when that difference may be incalculably important. It is a study which should bring into the laboratory and the classroom not only greater tolerance for the ideas of others but a clearer realization that even the scientific atmosphere evolves and changes with the society of which it is a part. When the student has become consciously aware of this, he is in a better position to see farther and more dispassionately in the guidance of his own research. A not unimportant by-product of such an awareness may be an extension of his own horizon as a human being.

I have sought to emphasize this point in my beginning discussion because several of my topics will be involved with the intellectual climate of the past. In conclusion I hope to venture some comment upon the world we now call "natural," as if, in some manner, we had tamed it sufficiently to include it under the category of "known and explored," as if it had little in the way of surprises yet

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in store for us. I shall want to look at this natural world both from the empirical point of view and from one which also takes into account that sense of awe and marvel which is part of man's primitive heritage, and without which man would not be man.

For many of us the Biblical bush still burns, and there is a deep mystery in the heart of a simple seed. If I seem for a time to be telling the story of how man came under the domain of law, how he reluctantly gave up his dreams and found his own footsteps wandering backward until on some far hillside they were transmuted into the footprints of a beast, it is only that we may assess more clearly that strange world into which we have been born —we, compounded of dust, and the light of a star.

Our first effort will be devoted to an examination of that universe which, in the unconsciously prophetic words of Sir Thomas Browne, "God seldom alters or perverts, but like an Excellent Artist, hath so contrived his work, that with the self-same instrument, without a new creation, he may effect his obscurest designs." When the great physician uttered those words in 1635 he was not thinking of evolution, but, as we shall see, he spoke like a blind oracle. The "self-same instrument" effecting design without creation would go unnoticed for two hundred years.

II

It is a moot question in history
existence man's earliest concepti
Certainly what we might call the
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and night—man must have been
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Divinity. Like most purely econo
of intellectual events, this is doub

tion of a complicated shift in intellectual emphasis. At all events, in the sixteenth and seventeenth centuries, law, natural law, the undeviating law of God, had taken precedence in intellectual circles over the world of the miraculous. There was a rising interest in the Second Book of Revelation; that is, nature. It was assumed that the two books, separately examined, would bear each other out—that the world could be read as though it were part of the Great Book. Since the God of the Old Testament was a God of wrath, it is not surprising that there lingered in the western mind a taste for the violent interpretation of geological events. Across eighteenth-century Europe lay the fallen, transported boulders of what seemed the visible evidence of some vast deluge. In the story of those stones, man's naïve faith in visible catastrophe is countered by the magnificent violence hidden in a raindrop.

III

Time and raindrops! It took enormous effort to discover the potentialities of both those forces. It took centuries before the faint trickling from cottage eaves and gutters caught the ear of some inquiring scholar. Men who could visualize readily the horrors of a universal Flood were deaf to the

roar of the invisible Niagara falling into the rain barrel outside their window. They could not hear it because they lived in a time span so short that the only way geologic change could be effected was by the convulsions of earthquakes, or the forty torrential days and nights that brought the Biblical Deluge.

The world of medieval thought was deeply centered upon itself and upon the traditional myths of Christianity. In spite of sectarian clashes, Christians of the prescientific era saw the earth essentially as the platform of a divine but short-lived drama—a drama so brief that there was little reason to study the stage properties. The full interest centered upon man—his supernatural origins, the drama of his Fall from the deathless Garden, the coming of his Redeemer, and the day of his Judgment.

Outside space was the Empyrean realm beyond time and blemish. Inside were corruption and a falling away from grace which were the consequence of man's sin. The atmosphere was not one to encourage scientific exploration. Men were busied about their souls, not about far voyages either in space or in time. They were contented with the European scene; they were devout and centered inward. It was indeed a centripetally directed society on an earth which itself lay at the center of the universe. Sinful though man had proved to be,

truths. The title of John Ray's well-known book, *The Wisdom of God Manifested in the Works of the Creation,* which first appeared in 1691, suggests this outlook. It did not prevent sharp observations from being made, nor a growing and persistent wonder about fossils, which were then called "formed stones."

Erosion was beginning to be faintly glimpsed as a power at work in nature. "That the height of the mountains doth continually diminish," muses John Ray, "is very likely." Our knowledge of time would have to be greatly altered before anyone would inquire whether persistent forces might be at work which would prevent the total denudation of the land and its eventual disappearance into the engulfing sea.

The change which was to pass over human thinking, however, began in the skies. This astronomical thinking has both its conservative and liberal side.

In the history of science, as in other history, there is rarely a specific place to begin a new story. For our purposes I will select just two events: the discovery of the speed of light, and Newton's formulation of the laws of gravitation. If we were to go farther back in time, we would, of course, have to treat of the opening out of space and the intellectual revolution introduced by the discovery that the earth was not the center of the solar system. Never-

idea of palingenesis (see Waters)

IV

THE scientific life of James Hutton extended over the last half of the eighteenth century. What Newton achieved and emphasized in astronomy and mathematics, Hutton accomplished in geology. It would be useless here to pursue all of the faint hints and intuitions about geological matters which preceded Hutton's work. They exist, but they do not lessen the fact that it was James Hutton of Edinburgh who, in diligent application of Newton's principles of experimental inquiry and observation, passed from the astronomer's conception of the self-correcting machine of the heavens to the idea that the earth itself constituted a machine which eternally reconstituted and renewed itself.

It has been pointed out that Hutton's doctoral dissertation was on the circulation of the blood in the Microcosm, that is, in man. It is an old idea in western thought, which persisted with unabated force into the eighteenth century, that man the microcosm reproduces in miniature, or is directly influenced by, the events of the Macrocosm, that is, the outside world, the universe. This idea lies at the root of astrology, and persists in a disguised form into modern times. It has been contended that Hutton, as a medical man, applied this idea to the earth, treating it as a living organism with circulation, metabolism, and other correspondences to the organic world. It has been termed Hutton's secret—a secret which happened to yield, in the case of geology, some remarkable insights, because it placed emphasis upon the dynamic qualities of the earth's crust—in short, upon the phenomena of decay and renewal.

It can be maintained, however, that just as Newton and his successors placed emphasis upon the giant celestial machine of the heavens—self-balancing and self-maintaining, set rolling by the hand of the Master Craftsman, God—so Hutton, influenced by this widespread conception, was the first to apply it to another seemingly self-renovating engine under divine care, the earth. Though Hutton, in later years, was not to escape the charge of heresy, the existing documents clearly suggest that he was less a cosmic evolutionist like Laplace than he was a true Newtonian, in that he abjured, or at least evaded, the question of the earth's origins. Rather, he dealt with the planet as a completed mechanism—whether we regard that mechanism as organic in essence or mechanical. He had accepted and read in the rocks, as the astronomers had begun to read in the skies, the message of time. Indeed he states forthrightly of the earth "that we find no vestige of a beginning, no prospect of an end."

Which, then, of these two views of Hutton's

achievement is correct? Is Hutton's a machine analogy or an organismic one? The machine analogy, at any rate, bulks large in the interpretation of eighteenth-century thought and descends into our own day. It is only by the hook of the analogy, by the root metaphor, as one philosopher has termed it, that science succeeds in extending its domain.

Occasionally, if not frequently, the analogy is false. Yet so potent is its effect upon a whole generation of scientific thinking that it may lie buried in the lowest stratum of accepted thought, or color unconsciously the thinking of entire generations. While proceeding with what is called "empirical research" and "experiment," the scientist will almost inevitably fit such experiments into an existing comprehensive framework, an integrative formula, until such time as that principle gives way to another. Let us see, in this connection, what ideas Hutton introduced into his examination of a previously neglected subject: the nature of the habitable earth.

V

We have earlier spoken of man's individual life views as colored and influenced by what he can perceive within that lifetime—what, in other words, he can personally observe. The individual

is loath to accept explanations of phenomena which come about as the result of forces exceeding the range of his own life span. If it is some type of natural landmark placed before his day, he is apt, rather than consider the effect of the accumulation of small events, to turn to myths incorporating outright violence on a gigantic scale. This, as we have already observed, is the first natural reaction of many laymen unacquainted with the history of geology today. In the seventeenth and eighteenth centuries science attempted its first groping entrance into the vast domain of time. It is not surprising, therefore, that what is now confined to the naïve and scientifically uneducated should have affected the reasoning even of scholars.

The Christian world accepted a surprisingly short time scale of a few thousand years. The calculations of such men as Bishop Ussher, based upon genealogical charts and other stray Biblical sources, were not an integral part of the Bible, but through long association with the volume they had become so. Moreover, the story of Creation, Eden, and the succeeding Flood all imply a world controlled and brought into being by direct supernatural methods which seemed to be devoted solely to the human drama. These had been the cherished beliefs of Christendom for over a thousand years. They were graven deep in the religious consciousness of scientist and layman alike. The Book of Nature sought

the dreadful culmination of heretical thought as it had afflicted France.

Political and religious considerations aside, however, catastrophism has an appeal of its own, even into our own day. No one likes to watch, listlessly, an hour hand go around the clock. We want the cuckoo bird to erupt violently at intervals from his little box, or a gong to strike. This catastrophism provided. Its time scale was scored and punctuated by violence.

Hutton, on the other hand, presents us with a quite different system. Instead of beginning with ancient catastrophes postulated upon giant tidal waves, he states with the utmost sobriety that "we are to examine the constructions of the present earth, in order to understand the natural operations of times past. The earth," he says, "like the body of an animal, is wasted at the same time that it is repaired. It has a state of growth and augmentation; it has another state, which is that of diminution and decay. This world is thus destroyed in one part, but it is renewed in another." Across Hutton's pages pass a series of small natural operations that over long time periods erode mountains, create valleys, and that, if mountain-building processes did not counteract their effect, would bring whole continents down to sea level.

He saw the bit of soil carried away by a mountain

brook or a spring freshet lodge in and nourish a lower valley; he saw the wind endlessly polishing and eroding stones on the high flanks of the world. He saw, with the marvelous all-seeing eye of Shakespeare, that "water-drops have worn the stones of Troy and blind oblivion swallowed cities up." He knew about the constant passage of water from sea to land and back again. If a leaf fell he knew where it was bound, and multiplied it mentally by ten thousand leaves in ten thousand, thousand autumns. One has the feeling that he sensed, on his remote Scottish farm, when frost split a stone on a winter night. Or when one boulder, poised precariously on a far mountain side, fell after a thousand years. For him and him alone, the water dripping from the cottagers' eaves had become Niagaras falling through unplumbed millennia. "Nature," he wrote simply, "lives in motion." Every particle in the world was hurrying somewhere, or was so destined in the long traverse of time.

In his observation that land was being created while land was being worn away, that there was continental elevation as well as denudation, Hutton shows a great grasp of the earth's interior powers. Though it was impossible for him to be totally correct in small details, he was almost alone in his recognition of the geostrophic cycle.

James Hutton had come upon the secret of the

worlds are real and sufficiently natural. We can say, if we like, that the muskrat's world is naïve and limited, a fraction, a bare fraction, of the world of life: a view from a little pile of wet stones on a nameless shore. The view of the motor speedsters in essence is similar and no less naïve. All would give way to the priority of that desperate professor, striving like a tired swimmer to hold himself aloft against the soft and fluid nothingness beneath his feet. In terms of the modern temper, the physicist has penetrated the deepest into life. He has come to that place of whirling sparks which are themselves phantoms. He is close upon the void where science ends and the manifestation of God's Prerogative begins. "He can be no creature," argued Donne, "who is present at the first creation."

Yet there is a way in which the intelligence of man in this era of science and the machine can be viewed as having taken the wrong turning. There is a dislocation of our vision which is, perhaps, the product of the kind of creatures we are, or at least conceive ourselves to be. As we mentioned earlier, man, as a two-handed manipulator of the world about him, has projected himself outward upon his surroundings in a way impossible to other creatures. He has done this since the first half-human man-ape hefted a stone in his hand. He has always sought mastery over the materials of his en-

vironment, and in our day he has pierced so deeply through the screen of appearances that the age-old distinctions between matter and energy have been dimmed to the point of disappearance. The creations of his clever intellect ride in the skies and the sea's depths; he has hurled a great fragment of metal at the moon, which he once feared. He holds the heat of suns within his hands and threatens with it both the lives and happiness of his unborn descendants.

Man, in the words of one astute biologist, is "caught in a physiological trap and faced with the problem of escaping from his own ingenuity." Pascal, with intuitive sensitivity, saw this at the very dawn of the modern era in science. "There is nothing which we cannot make natural," he wrote, and then, prophetically, comes the full weight of his judgment upon man, "there is nothing natural which we do not destroy." *Homo faber,* the tool-maker, is not enough. There must be another road and another kind of man lurking in the mind of this odd creature, but whether the attraction of that path is as strong as the age-old primate addiction to taking things apart remains to be seen.

We who are engaged in the life of thought are likely to assume that the key to an understanding of the world is knowledge, both of the past and of the future—that if we had that knowledge we

would also have wisdom. It is not my intention here to decry learning. It is only to say that we must come to understand that learning is endless and that nowhere does it lead us behind the existent world. It may reduce the prejudices of ignorance, set our bones, build our cities. In itself it will never make us ethical men. Yet because ours, we conceive, is an age of progress, and because we know more about time and history than any men before us, we fallaciously equate ethical advance with scientific progress in a point-to-point relationship. Thus as society improves physically, we assume the improvement of the individual, and are all the more horrified at those mass movements of terror which have so typified the first half of this century.

On the morning of which I want to speak, I was surfeited with the smell of mortality and tired of the years I had spent in archaeological dustbins. I rode out of a camp and across a mountain. I would never have believed, before it happened, that one could ride into the past on horseback. It is true I rode with a purpose, but that purpose was to settle an argument within myself.

It was time, I thought, to face up to what was in my mind—to the dust and the broken teeth and the spilled chemicals of life seeping away into the sand. It was time I admitted that life was of the earth, earthy, and could be turned into a piece of

wretched tar. It was time I consented to
osition that man had as little to do with
as a seed blown against a grating. It wa
looked upon the world without spectacles
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juices. I could be an empiricist with th
them. I would be deceived by no more
had entered a black cloud of merciless
but the horse, as it chanced, worked his
over that mountain.

I could hear the sudden ring of his hoo
came cautiously treading over a tilted
granite, past the winds that blow on the hi
of the world. There were stones there so
that they shone from the long ages that th
had rushed across them. We crossed th
then, picking our way in places scoured b
ice action, through boulder fields where
moved, and yet where one could feel tim
enemy hidden behind each stone.

If there was life on those heights, it was
life of mountain spiders who caught no
their webs, or of small gray birds that
soundlessly among the stones. The wind
pass caught me head on and blew
thoughts I had into a raveling stream bel
until they were all gone and there was onl
and the horse, moving in an eternal da
present, free of the encumbrances of t

eenth-century rationalists—a kind of emergent, if not miraculous, novelty.

I know that the word "miraculous" is regarded dubiously in scientific circles because of past quarrels with theologians. The word has been defined, however, as an event transcending the known laws of nature. Since, as we have seen, the laws of nature have a way of being altered from one generation of scientists to the next, a little taste for the miraculous in this broad sense will do us no harm. We forget that nature itself is one vast miracle transcending the reality of night and nothingness. We forget that each one of us in his personal life repeats that miracle.

Whatever may be the power behind those dancing motes to which the physicist has penetrated, it makes the light of the muskrat's world as it makes the world of the great poet. It makes, in fact, all of the innumerable and private worlds which exist in the heads of men. There is a sense in which we can say that the planet, with its strange freight of life, is always just passing from the unnatural to the natural, from that Unseen which man has always reverenced to the small reality of the day. If all life were to be swept from the world, leaving only its chemical constituents, no visitor from another star would be able to establish the reality of such a phantom. The dust would lie without

the eggs somewhere about, and whether they were to elongate and writhe into an armor of scales, or eventually to go whistling into the wind with their wild mother.

So I, the mammal, in my way supple, and less bound by instinct, arbitrated the matter. I unwound the serpent from the bird and let him hiss and wrap his battered coils around my arm. The bird, her wings flung out, rocked on her legs and gasped repeatedly. I moved away in order not to drive her further from her nest. Thus the serpent and I, two terrible and feared beings, passed quickly out of view.

Over the next ridge, where he could do no more damage, I let the snake, whose anger had subsided, slowly uncoil and slither from my arm. He flowed away into a little patch of bunch grass—aloof, forgetting, unaware of the journey he had made upon my wrist, which throbbed from his expert constriction. The bird had contended for birds against the oncoming future; the serpent writhing into the bunch grass had contended just as desperately for serpents. And I, the apparition in that valley—for what had I contended?—I who contained the serpent and the bird and who read the past long written in their bodies.

Slowly, as I sauntered dwarfed among overhanging pinnacles, as the great slabs which were the visible remnants of past ages laid their enormous

shadows rhythmically as life and death across my face, the answer came to me. Man could contain more than himself. Among these many appearances that flew, or swam in the waters, or wavered momentarily into being, man alone possessed that unique ability.

The Renaissance thinkers were right when they said that man, the Microcosm, contains the Macrocosm. I had touched the lives of creatures other than myself and had seen their shapes waver and blow like smoke through the corridors of time. I had watched, with sudden concentrated attention, myself, this brain, unrolling from the seed like a genie from a bottle, and casting my eyes forward, I had seen it vanish again into the formless alchemies of the earth.

For what then had I contended, weighing the serpent with the bird in that wild valley? I had struggled, I am now convinced, for a greater, more comprehensive version of myself.

IV

I AM a man who has spent a great deal of his life on his knees, though not in prayer. I do not say this last pridefully, but with the feeling that the posture, if not the thought behind it, may have had some final salutary effect. I am a naturalist and a

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through life. I have crawled downw
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fossil hunter, and I have crawled most of the way through life. I have crawled downward into holes without a bottom, and upward, wedged into crevices where the wind and the birds scream at you until the sound of a falling pebble is enough to make the sick heart lurch. In man, I know now, there is no such thing as wisdom. I have learned this with my face against the ground. It is a very difficult thing for a man to grasp today, because of his power; yet in his brain there is really only a sort of universal marsh, spotted at intervals by quaking green islands representing the elusive stability of modern science—islands frequently gone as soon as glimpsed.

It is our custom to deny this; we are men of precision, measurement and logic; we abhor the unexplainable and reject it. This, too, is a green island. We wish our lives to be one continuous growth in knowledge; indeed, we expect them to be. Yet well over a hundred years ago Kierkegaard observed that maturity consists in the discovery that "there comes a critical moment where everything is reversed, after which the point becomes to understand more and more that there is something which cannot be understood."

When I separated the serpent from the bird and released them in that wild upland, it was not for knowledge; not for anything I had learned in science. Instead, I contained, to put it simply, the