

“HOW FLOWERS CHANGED THE WORLD”

If it had been possible to observe the Earth from the far side of the solar system over the long course of geological epochs, the watchers might have been able to discern a subtle change in the light emanating from our planet. That world of long ago would, like the red deserts of Mars, have reflected light from vast drifts of stone and gravel, the sands of wandering wastes, the blackness of naked basalt, the yellow dust of endlessly moving storms. Only the ceaseless marching of the clouds and the intermittent flashes from the restless surface of the sea would have told a different story, but still essentially a barren one. Then, as the millennia rolled away and age followed age, a new and greener light would, by degrees, have come to twinkle across those endless miles.

This is the only difference those far watchers, by the use of subtle instruments, might have perceived in the whole history of the planet Earth. Yet that slowly growing green twinkle would have contained the epic march of life from the tidal oozes upward across the raw and unclothed continents. Out of the vast chemical bath of the sea – not from the deeps, but from the element-rich, light-exposed platforms of the continental shelves – wandering fingers of green had crept upward along the meanderings of river systems and fringed the gravels of forgotten lakes.

In those first ages plants clung of necessity to swamps and watercourses. Their reproductive processes demanded direct access to water. Beyond the primitive ferns and mosses that enclosed the borders of swamps and streams the rocks still lay vast and bare, the winds still swirled the dust of a naked planet. The grass cover that holds our world secure in place was still millions of years in the future. The green marchers had gained a soggy foothold upon the land, but that was all. They did not reproduce by seeds but by microscopic swimming sperm that had to wriggle their way through water to fertilize the female cell. Such plants in their higher forms had clever adaptations for the use of rain water in their sexual phases, and survived with increasing success in a wetland environment. They now seem part of man’s normal environment. The truth is, however, that there is nothing very “normal” about nature, Once upon a time there were no flowers at all.

A little while ago – about one hundred million years, as the geologist estimates time in the history of our four-billion-year-old planet – flowers were not to be found anywhere on the five continents. Wherever one might have looked, from the poles to the equator, one would have seen only the cold dark monotonous green of a world whose plant life possessed no other color.

Somewhere, just a short time before the close of the Age of Reptiles, there occurred a soundless, violent explosion. It lasted millions of years, but it was an explosion, nevertheless. It marked the emergence of the angiosperms – the flowering plants, Even

the great evolutionist, Charles Darwin, called them “an abominable mystery,” because they appeared so suddenly and spread so fast.

Flowers changed the face of the planet. Without them, the world we know – even man himself – would never have existed. Francis Thompson, the English poet, once wrote that one could not pluck a flower without troubling a star. Intuitively he had sensed like a naturalist the enormous interlinked complexity of life. Today we know that the appearance of the flowers contained also the equally mystifying emergence of man.

If we were to go back into the Age of Reptiles, its drowned swamps and birdless forests would reveal to us a warmer but, on the whole, a sleepier world than that of today. Here and there, it is true, the serpent heads of bottom-feeding dinosaurs might be upreared in suspicion of their huge flesh-eating compatriots. Tyrannosaurs, enormous bipedal caricatures of men, would stalk mindlessly across the sites of future cities and go their slow way down into the dark of geologic time.

In all that world of living things, nothing saw save with the intense concentration of the hunt, nothing moved except with the grave sleepwalking intentness of the instinct-driven brain. Judged by modern standards, it was a world in slow motion, a cold-blooded world whose occupants were most active at noonday but torpid on chill nights, their brains damped by a slower metabolism than any known to even the most primitive of warm-blooded animals today.

A high metabolic rate and the maintenance of a constant body temperature are supreme achievements in the evolution of life. They enable an animal to escape, within broad limits, from the overheating or the chilling of its immediate surroundings, and at the same time to maintain a peak mental efficiency. Creatures without a high metabolic rate are slaves to weather. Insects in the first frosts of autumn all run down like little clocks. Yet if you pick one up and breathe warmly upon it, it will begin to move about once more.

In a sheltered spot such creatures may sleep away the winter, but they are hopelessly immobilized. Though a few warm-blooded mammals, such as the woodchuck of our day, have evolved a way of reducing their metabolic rate in order to undergo winter hibernation, it is a survival mechanism with drawbacks, for it leaves the animal helplessly exposed if enemies discover him during his period of suspended animation. Thus bear or woodchuck, big animal or small, must seek, in this time of descending sleep, a safe refuge in some hidden den or burrow. Hibernation is, therefore, primarily a winter refuge of small, easily concealed animals rather than of large ones.

A high metabolic rate, however, means a heavy intake of energy in order to sustain body warmth and efficiency. It is for this reason that even some of these later warm-blooded mammals existing in our day have learned to descend into a slower, unconscious rate of living during the winter months when food may be difficult to obtain. On a slightly higher plane they are following the procedure of the cold-blooded frog sleeping in the mud at the bottom of a frozen pond.

The agile brain of the warm-blooded birds and mammals demands a high oxygen consumption and food in concentrated forms, or the creatures cannot long sustain themselves. It was the rise of the flowering plants that provided that energy and changed the nature of the living world. Their appearance parallels in a quite surprising manner the rise of the birds and mammals.

Slowly, toward the dawn of the Age of Reptiles, something over two hundred and fifty million years ago, the little naked sperm cells wriggling their way through dew and raindrops had given way to a kind of pollen carried by the wind. Our present-day pine forests represent plants of a pollen-disseminating variety. Once fertilization was no longer dependent on exterior water, the march over drier regions could be extended. Instead of spores, simple primitive seeds carrying some nourishment for the young plant had developed, but true flowers were still scores of millions of years away. After a long period of hesitant evolutionary groping, they exploded upon the world with truly revolutionary violence.

The event occurred in Cretaceous times in the close of the Age of Reptiles. Before the coming of the flowering plants our own ancestral stock, the warm-blooded mammals, consisted of few mousy little creatures hidden in trees and underbrush. A few lizard-like birds with carnivorous teeth flapped awkwardly on ill-aimed flights among archaic shrubbery. None of these insignificant creatures gave evidence of any remarkable talents. The mammals in particular had been around for some millions of years, but had remained well lost in the shadow of the mighty reptiles. Truth to tell, man was still, like the genie in the bottle, encased in the body of a creature about the size of a rat.

As for the birds, their reptilian cousins the Pterodactyls, flew farther and better. There was just one thing about the birds that paralleled the physiology of the mammals. They, too, had evolved warm blood and its accompanying temperature control. Nevertheless, if one had been seen stripped of his feathers, he would still have seemed a slightly uncanny and unsightly lizard.

Neither the birds nor the mammals, however, were quite what they seemed. They were waiting for the Age of Flowers. They were waiting for what flowers, and with them the true encased seed, would bring. Fish-eating, gigantic leather-winged reptiles, twenty-eight feet from wing tip to wing tip, hovered over the coasts that one day would be swarming with gulls.

Inland the monotonous green of the pine and spruce forest with their primitive wooden cone flowers stretched everywhere. No grass hindered the fall of the naked seeds to earth. Great sequoias towered to the skies. The world of that time has a certain appeal but it is a giant's world, a world moving slowly like the reptiles who stalked magnificently among the boles of its trees.

The trees themselves are ancient, slow-growing and immense, like the redwood groves that have survived to our day on the California coast. All is stiff, formal, upright and green, monotonously green. There is no grass as yet; there are no wide plains rolling in

the sun, no tiny daisies dotting the meadows underfoot. There is little versatility about this scene; it is, in truth, a giant's world.

A few nights ago it was brought home vividly to me that the world has changed since that far epoch. I was awakened out of sleep by an unknown sound in my living room. Not a small sound – not a creaking timber or a mouse's scurry – but a sharp, rending explosion as though an unwary foot had been put down upon a wine glass. I had come instantly out of sleep and lay tense, unbreathing. I listened for another step. There was none.

Unable to stand the suspense any longer, I turned on the light and passed from room to room glancing uneasily behind chairs and into closets. Nothing seemed disturbed, and I stood puzzled in the center of the living room floor. Then a small button-shaped object upon the rug caught my eye. It was hard and polished and glistening. Scattered over the length of the room were several more shining up at me like wary little eyes. A pine cone that had been lying in a dish had been blown the length of the coffee table. The dish itself could hardly have been the source of the explosion. Beside it I found two ribbon-like strips of a velvety-green. I tried to place the two strips together to make a pod. They twisted resolutely away from each other and would no longer fit.

I relaxed in a chair, then, for I had reached a solution of the midnight disturbance. The twisted strips were wisteria pods that I had brought in a day or two previously and placed in the dish. They had chosen midnight to explode and distribute their multiplying fund of life down the length of the room. A plant, a fixed, rooted thing, immobilized in a single spot, had devised a way of propelling its offspring across open space. Immediately there passed before my eyes the million airy troopers of the milkweed pod and the clutching hooks of the sandburs. Seeds on the coyote's tail, seeds on the hunter's coat, thistledown mounting on the winds – all were somehow triumphing over life's limitations. Yet the ability to do this had not been with them at the beginning. It was the product of endless effort and experiment.

The seeds on my carpet were not going to lie stiffly where they had dropped like their antiquated cousins, the naked seeds on the pine cone scales. They were travelers. Struck by the thought, I went out next day and collected several other varieties. I line them up now in a row on my desk – so many little capsules of life, winged, hooked or spiked. Every one is an angiosperm, a product of the true flowering plants. Contained in these little boxes is the secret of that far-off Cretaceous explosion of a hundred million years ago that changed the face of the planet. And somewhere in here, I think, as I poke seriously at one particularly resistant seedcase of a wild grass, was once man himself.

When the first simple flower bloomed on some raw upland late in the Dinosaur Age, it was wind pollinated, just like its early pine-cone relatives. It was a very inconspicuous flower because it had not yet evolved the idea of using the surer attraction of birds and insects to achieve the transportation of pollen. It sowed its own pollen and received the pollen of other flowers by the simple vagaries of the wind. Many plants in regions

where insect life is scant still follow this principle today. Nevertheless, the true flower – and the seed that it produced – was a profound innovation in the world of life.

In a way, this event parallels, in the plant world, what happened among animals. Consider the relative chance for survival of the exteriorly deposited egg of a fish in contrast with the fertilized egg of a mammal, carefully retained for months in the mother's body until the young animal (or human being) is developed to a point where it may survive. The biological wastage is less – and so it is with the flowering plants. The primitive spore, a single cell fertilized in the beginning by a swimming sperm, did not promote rapid distribution, and the young plant, moreover, had to struggle up from nothing. No one had left it any food except what it could get by its own unaided efforts.

By contrast, the true flowering plants (angiosperm itself means “encased seed”) grew a seed in the heart of a flower, a seed whose development was initiated by a fertilizing pollen grain independent of outside moisture. But the seed, unlike the developing spore, is already a fully equipped embryonic plant packed in a little enclosed box stuffed full of nutritious food. Moreover, by featherdown attachments, as in dandelion or milkweed seed, it can be wafted upward on gusts and ride the wind for miles; or with hooks it can cling to a bear's or a rabbit's hide; or like some of the berries, it can be covered with a juicy, attractive fruit to lure birds, pass undigested through their intestinal tracts and be voided miles away.

The ramifications of this biological invention were endless. Plants traveled as they had never traveled before. They got into strange environments heretofore never entered by the old spore plants or stiff pine cone-seed plants. The well-fed, carefully cherished little embryos raised their heads everywhere. Many of the older plants with more primitive reproductive mechanisms began to fade away under this unequal contest. They contracted their range into secluded environments. Some, like the giant redwoods, lingered on as relics; many vanished entirely.

The world of the giants was a dying world. These fantastic little seeds skipping and hopping and flying about the woods and valleys brought with them an amazing adaptability. If our whole lives had not been spent in the midst of it, it would astound us. The old, stiff, sky-reaching wooden world had changed into something that glowed here and there with strange colors, put out queer, unheard-of fruits and little intricately carved seed cases, and, most important of all, produced concentrated foods in a way that the land had never seen before, or dreamed of back in the fish-eating, leaf-crunching days of the dinosaurs.

That food came from three sources, all produced by the reproductive system of the flowering plants. There were the tantalizing nectars and pollen intended to draw insects for pollenizing purposes, and which are responsible also for that wonderful jeweled creation, the hummingbird. There were the juicy and enticing fruits to attract larger animals, and in which tough-coated seeds were concealed, as in the tomato, for example. Then, as if this were not enough, there was the food in the actual seed itself, the food intended to nourish the embryo. All over the world, like hot corn in a popper,

these incredible elaborations of the flowering plants kept exploding. In a movement that was almost instantaneous, geologically speaking, the angiosperms had taken over the world. Grass was beginning to cover the bare earth until, today, there are over six thousand species. All kinds of vines and bushes squirmed and writhed under new trees with flying seeds.

The explosion was having its effect on animal life also. Specialized groups of insects were arising to feed on the new sources of food and, incidentally and unknowingly, to pollinate the plant. The flowers bloomed and bloomed in ever larger and more spectacular varieties. Some were pale unearthly night flowers intended to lure moths in the evening twilight, some among the orchids even took the shape of female spiders in order to attract wandering males, some flamed redly in the light of noon or twinkled modestly in the meadow grasses. Intricate mechanisms splashed pollen on the breasts of hummingbirds, or stamped it on the bellies of black, grumbling bees droning assiduously from blossom to blossom. Honey ran, insects multiplied, and even the descendants of that toothed and ancient lizard-bird had become strangely altered. Equipped with prodding beaks instead of biting teeth they pecked the seeds and gobbled the insects that were really converted nectar.

Across the planet grasslands were now spreading. A slow continental upthrust which had been a part of the early Age of Flowers had cooled the world's climates. The stalking reptiles and the leather-winged black imps of the seashore cliffs had vanished. Only birds roamed the air now, hot-blooded and high-speed metabolic machines.

The mammals, too, had survived and were venturing into new domains, staring about perhaps a bit bewildered at their sudden eminence now that the thunder lizards were gone. Many of them, beginning as small browsers upon leaves in the forest, began to venture out upon this new sunlit world of the grass. Grass has a high silica content and demands a new type of very tough and resistant tooth enamel, but the seeds taken incidentally in the cropping of the grass are highly nutritious. A new world had opened out for the warm-blooded mammals. Great herbivores like the mammoths, horses and bisons appeared. Skulking about them had arisen savage flesh-feeding carnivores like the now extinct dire wolves and the saber-toothed tiger.

Flesh eaters though these creatures were, they were being sustained on nutritious grasses one step removed. Their fierce energy was being maintained on a high, effective level, through hot days and frosty nights, by the concentrated energy of the angiosperms. That energy, thirty per cent or more of the weight of the entire plant among some of the cereal grasses, was being accumulated and concentrated in the rich proteins and fats of the enormous game herds of the grasslands.

On the edge of the forest, a strange, old-fashioned animal still hesitated. His body was the body of a tree dweller, and though tough and knotty by human standards, he was, in terms of that world into which he gazed, a weakling. His teeth, though strong for chewing on the tough fruits of the forest, or for crunching an occasional unwary bird caught with his prehensile hands, were not the tearing sabers of the great cats. He had a

passion for lifting himself up to see about, in his restless, roving curiosity. He would run a little stiffly and uncertainly, perhaps, on his hind legs, but only in those rare moments when he ventured out upon the ground. All this was the legacy of his climbing days; he had a hand with flexible fingers and no fine specialized hoofs upon which to gallop like the wind.

If he had any idea of competing in that new world, he had better forget it; teeth or hooves, he was much too late for either. He was a ne'er-do-well, an in-between. Nature had not done well by him. It was as if she had hesitated and never quite made up her mind. Perhaps as a consequence he had a malicious gleam in his eye, the gleam of an outcast who has been left nothing and knows he is going to have to take what he gets. One day a little band of these odd apes – for apes they were – shambled out upon the grass; the human story had begun.

Apes were to become men, in the inscrutable wisdom of nature, because flowers had produced seeds and fruits in such tremendous quantities that a new and totally different store of energy had become available in concentrated form. Impressive as the slow-moving, dim-brained dinosaurs had been, it is doubtful if their age had supported anything like the diversity of life that now rioted across the planet or flashed in and out among the trees. Down on the grass by a streamside, one of those apes with inquisitive fingers turned over a stone and hefted it vaguely. The group clucked together in a throaty tongue and moved off through the tall grass foraging for seeds and insects. The one still held, sniffed, and hefted the stone he had found. He liked the feel of it in his fingers. The attack on the animal world was about to begin.

If one could run the story of that first human group like a speeded-up motion picture through a million years of time, one might see the stone in the hand change to the flint ax and the torch. All that swarming grassland world with its giant bison and trumpeting mammoths would go down in ruin to feed the insatiable and growing numbers of a carnivore who, like the great cats before him, was taking his energy indirectly from the grass. Later he found fire and it altered the tough meats and drained their energy even faster into a stomach ill adapted for the ferocious turn man's habits had taken.

His limbs grew longer, he strode more purposefully over the grass. The stolen energy that would take man across the continents would fail him at last. The great Ice Age herds were destined to vanish. When they did so, another hand like the hand that grasped the stone by the river long ago would pluck a handful of grass seed and hold it contemplatively. In that moment, the golden towers of man, his swarming millions, his turning wheels, the vast learning of his packed libraries, would glimmer dimly there in the ancestor of wheat, a few seeds held in a muddy hand. Without the gift of flowers and the infinite diversity of their fruits, man and bird, if they had continued to exist at all, would be today unrecognizable. Archaeopteryx, the lizard-bird, might still be snapping at beetles on a sequoia limb; man might still be a nocturnal insectivore

gnawing a roach in the dark. The weight of a petal has changed the face of the world and made it ours.