A New Concept of Origin and Evolution*

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Since Darwin wrote his thought provoking paper on Natural Selection in 1859, work has continued to be directed toward further enlightenment on the subject of origin and evolution. Today there still are puzzling angles to be considered and explained. For example, the presence in the Devonian of a well-developed flora and fauna about the poles, the fossils of which give every evidence of having been developed in a warm climate, is difficult of explanation in the light of climatic conditions as they are today. The occurrence of such a flora at so early an age as the Devonian does not make matters clearer. Seward in "Plant Life Through the Ages," said, and passingly reaffirmed again in his address as President of the British Association for the Advancement of Science on August 30th, 1939, "The existence as far north as Lat. 77° N. of a luxuriant vegetation, including plants in no way inferior in development to the closely allied or identical species of the Donetz Basin of Russia, raises the difficult question of climatic contrast between the past and the present, a problem which confronts us through the whole of geological history and still awaits a satisfactory solution." The puzzling situation of fossilized plants in the Arctic, similar to plants of warm regions, has been a difficult thing to explain.

In the course of a series of studies begun more than a dozen years ago and undertaken with more vigor during the past five years, a number of interesting points bearing upon the subject have come to mind and are deemed worthy of recording. Any thought given the matter must of necessity assume at this time a consideration of the beginnings of the earth as well as a theoretical consideration of the whole solar system. Rising on strong wings, one must view the drama of the universe, and of life, from afar. We must appreciate the insignificant span of recorded human history as compared to the present age of the earth and its unreckoned future.

Since this paper is to have an ecological outlook, it would seem fitting to define our term. This may be fatuous, but ecology is a study of the interrelationships of various plants growing together under variable conditions of moisture, temperature, light and edaphic conditions.

It would seem to me justifiable to assign to the earth a period of existence just as to everything else which we know. On this curve of existence the earth is traveling along and will eventually reach maturity and old age, then will presumably lose all those delightful attributes which are part of it today. If this be true then the earth

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may have run some distance in maturity—to such an extent that I now believe it to be declining.

Scientific work has produced much evidence of former floras now existing as fossils about the North and South Poles, despite the fact that these poles are the very antithesis of one another. The North Pole is in the midst of a great Polar Sea whose islands bear the fossil evidence, while the South Pole is located on a great elevated land mass with many high mountains. These fossil records leave little doubt as to the authenticity of such early floras. If we assign these fossils to the polar regions by right of plants which have grown there, then we must logically expect that the climates there at that time were at least somewhat similar to the climates where their nearest relatives are living today. The progenitors of so well-developed a flora would be expected to have antedated them in the region where the fossils are found. Since their nearest living relatives today are tropical, subtropical, or warm temperate, we must believe then that the poles were once possessed of a somewhat warmer climate.

It has been the practice of some paleobotanists, puzzled by the discovery within the polar regions of fossils of former plants and animals closely allied to those of the subtropical or even the tropical, to assume instability of the earth's axis. Accurate measurements have given little encouragement to the theory of drifting continental masses, though in fairness it must be said that the lapse of time seems inadequate to be sure of conclusions from such measurement. If we do not accept the Wegenerian hypothesis of drifting continents we must seek other explanations. We are led to believe that uniformity of climate would seem to account for world-wide distribution of Archeopteris and other genera in the Devonian. But need this have been uniformity? Perhaps it may have been progressive development as climate and vegetation progressed through easy stages from the poles equator-ward. Our thinking is often conditioned by the present and we sometimes fail to remember that past climates need not necessarily have been the same as now. We come to think that the polar regions should always have been cold. I believe the poles have been cooler than the equator since the first crustal formations; that is, when they were first cool enough for life to exist the equator was too hot for life to develop. This may account for the few specimens of Devonian flora found equator-ward beyond the Tropic of Cancer and Tropic of Capricorn.

Jeffery says that the more ancient the epoch, the warmer the climate; and also that there has been a gradual and progressive refrigeration during geologic times. He believes the organization of secondary wood in extinct plants furnishes the most reliable evidence of climatic conditions, for toward the end of the Paleozoic, growth rings began to appear in woods in high latitudes; tangential pitting did not appear before the early Mesozoic. He also holds that in the Triassic, growth rings were developed 10° nearer the equator than was the case in the Paleozoic and that in the Triassic, tracheids first developed tangential pitting which was at the end of the annual ring and accompanied by storage elements.

The Devonian Age antedates by more than 100,000,000 years the first recognizable remains of the present dominant forms of Angiosperms. The primitive ancestors of these present great classes may have existed at a much earlier moment than we now generally believe. We know that before the end of the Devonian all the larger classes of plants were represented and had colonized widely. Many forms are known from the late Silurian.

The proximity of cold and warm, hot and dry climates have been puzzling but we have alpine and tropical plants on the earth today growing within a few miles of each other. Because plants have not been found in the rocks as fossil is not conclusive proof that they do not exist. Geologists and paleobotanists often say that certain rocks are without fossils, forgetting that the part they have seen, or that all men have seen, is an insignificant part of that existing. What is steadfastly adhered to today has a way of being proved wrong tomorrow. One must never be too sure that discoveries represent general conditions during an age, and not a small section of an environment. There is always the possibility of mistakes such as was made on Nematophyton, a Silurian plant which was classified by Sir William Dawson as a Prototaxites and related to the Yews, when it actually was classed later as an alga. We know that the lower Devonian has yielded fragments of plants which may have been the progenitors of higher plants today.

Seward says, "The old Red Sandstone of the Devonian in their characteristic colors have been regarded as evidence of a dry or semi-arid climate. Frequently lack of fossils, nature of the sediments and their structure and manner of occurrence support the view that the climatic conditions both on the Northern and some parts of the Southern hemisphere were similar to those in fairly dry regions and subject to occasional violent rain storms. It has been suggested with some degree of truth that the desert conditions were due not so much to lack of rain as to the presence of barren rock not yet clothed with protecting and moisture holding plants. Most Devonian fossils have come from the far North and the north temperate zone and from the southern borders of South America and South Africa and the southern half of Australia. We know practically nothing of the floras which flourished in the tropics." My contention is that they did not flourish there until a much later date, since it appears it may have been the last region of the earth to become populated by plants, as I shall try to explain later. In addition to this is the fact that Ellesmere Land and Bear Island of the Svalbard Archipelago, both lying in the vicinity of 80°N. latitude, and Australia at the opposite end of the earth, have many fossils which are well developed and belonging to several groups, some as high as the *Pteridospermae*. These forms belong to the Devonian flora and leave little doubt that the polar regions once supported a highly developed and varied plant life. Stefenssen states that he has taken specimens of coal from 79°N. which were undoubtedly coniferous. Today forests generally get no farther north than 68°, not limited by cold but by lack of summer heat. It is generally reasoned to have been a warm climate. The presence of the Marattiaceae, now tropical, in

the Devonian, is taken to indicate such affinities. Then, too, fossils of Sigillaria are present and bear cones on old wood, termed cauliflory, which is a characteristic of many tropical plants today. The Cycadean pattern of fossilized leaves is a character of present day Cycads. But modern Cycads are rather remote geologically and botanically to be considered strong evidence. Perhaps the most annoying character of Devonian plants to explain away is the general lack of rings in wood. This is rather peculiarly a tropical or uniform climatic trait.

The presence of so rich and widespread a flora in the Arctic during the Devonian can seem to be accounted for in only one of three ways:

1. That it sprang *de novo* into existence *in situ*.
2. That simpler forms of life existed in adjacent regions and that the Devonian flora arising from it migrated or drifted into the Polar region.
3. That the simpler forms which gave rise to these great Polar flora existed coextensively with them and that their fossils are there in Polar rocks and as yet undiscovered.

No scientist will be willing to admit the first as an explanation of origin. Migration would not seem to be the answer. If drifting land masses played a part, then the progenitors of such a flora should be found in the rocks with them. While there is little definite supporting evidence for drifting continents, I believe there is none strikingly refuting it. The third possibility seems the most plausible; namely, that the elementary forms which gave rise to Devonian floras about the North Pole arose and are there as fossils in the rocks, so far as they were capable of being fossilized. They are yet to be discovered. It seems patent that this original flora, and the fauna too, must have been developed about the poles under salubrious conditions akin to—if not actually tropical. An explanation in support of such viewpoints is here to be projected. It is not entirely new, having been advanced in part by Manson and later expanded by Knowlton.

It is believed that the earth was formed as a hot molten mass of gas which finally solidified. The terrestrial radiation of this hot molten mass which was to become the earth must have been very great after its inception, far exceeding the effects of solar radiation upon which the tropics and our present day life on earth are so dependent.

Life was impossible at such a time and could not have come into existence until terrestrial cooling brought about the equable and expedient climate necessary for the existence of living things. These requirements were fulfilled as the earth cooled to temperatures where protoplasm could exist. Under such cooling, various gases lowered and approached the earth. The vertical rays of the sun, added to that of the terrestrial heat, made it hotter and humid more at the equator than at the poles as the clouds dispersed. Such a change resulted in a moderation of the untenable climate at the poles with the accompanying hardening of the earth's crust and its gradual warping to form the unfilled oceans and lakes. The earth's cooling, therefore, is believed to have begun at the poles because the terrestrial heat was the dominant influencing factor, since it predominated throughout the years.

More equatorward the sun became a greater and greater factor. It is possible that at this early date the sun was hotter than it is today because it has been constantly radiating energy. This, however, is a point in dispute. Further terrestrial cooling caused a continual lowering of the earth's atmosphere. Rain must have fallen.

With the falling of rain, erosion began and great quantities of salts were probably quickly washed away, along with other materials, to become the solutes of our first oceans. The accumulation of weight in the oceans, together with the surface cooling of the earth, caused the crust to shrink, buckling the coast lines upward into high mountains which could account for the diversified climates at various places on the earth's surface. Cracks in the surface permitted the pouring of magma from the interior of the earth over the land and are presumed to have accounted for elevations and lowlands, as well as formation of deserts which were probably only exposed rock.

Reduction of the moisture in the atmosphere introduced a new feature. The diminishing moisture in the atmosphere at the poles permitted the cooler air from the upper regions to strike the earth and thus become a real factor in cooling it. As the temperature at the poles was thus reduced, there came eventually a time when conditions were correct for the development of the first forms of life. Such, I believe, were first reached in the water in the environs of the Polar regions.

Berry says of the Devonian flora of the Arctic: "Plants of the Devonian are so remote from living forms that I do not feel that any conclusions regarding the climate are warranted beyond the statement that they show that there have been no barriers to prevent most of the types formed in latitude 45° to 50° extending northward to latitude 75°." I cannot see why the escape was polarward and not equatorward. Seward says, "Uniformity of climate would account for world-wide distribution of Archeopteris and other genera." But I ask, need this have been a uniform climate? Perhaps it has been progressive development as adjusted climate and vegetation travel along in easy stages equatorward. Successions do this, today, over millions of smaller areas and pollen studies have shown the same thing for earlier ages.

As conditions at the poles changed by further cooling, the original conditions for the formation of life migrated from Polar regions. It seems plausible that various forms invaded the land, then traveled equatorward with the newly established forms migrating in their proper environmental conditions. Similar forms of life may have formed over and over again. As the earth continued to cool slowly, the proper zone for elementary forms of life passed farther and farther equatorward. Selection and adaptation determined survivals, which produced the next higher forms of life polarward, where old environments had changed. I envisage wave after wave of such zones of life following one another through the years in orderly fashion equatorward, just as vegetational successions follow one another today about an ageing pond, but in reverse order due to increasing desiccation. Millions of years of evolution had developed higher plants. As the environment

changed, each succession was followed by one a step higher in evolutionary development so that the covering of vegetation developed on the earth has been like a series of gigantic ecological successions which reached its peak in tropical vegetation. It is realized that many crustal movements have disturbed uniform and even development. The heat from a cooling earth and a slowly declining sun has now ebbed until such warm conditions have reached the Torrid Zone, there to become tropical by the influence of solar heat. The tropical conditions equatorward were followed in turn by those more temperate and farther polarward by cold and even frigid conditions. A study of vegetation from the poles equatorward today will show a series of plants from tundra through willow, birches, spruces, pines, hardwoods, to tropics, very much like ecological successions which occur in isolated places all over the earth—always in definite but reverse order, and this due to desiccation. Any cloud blanket present is now gone but for the remnants in the tropics and scattered ones about the earth which are but the playthings of meteorological whims. Thus we have passed first from desiccation of the earth by heat to conditions favorable for the origin of life, then to a rich flora, and finally to desiccation by cold, and our impoverished flora of today. I believe life may have arisen simultaneously at both poles, where conditions of temperature may have been similar and perhaps even the chemical and physical conditions in agreement.

Cold water in the polar regions must have passed readily from them and flowed into the warm oceans or escaped through wind currents in the form of fog into the more favorable moisture-holding temperatures equatorward, which condition is well known to exist today. This caused further desiccation, lessening still more the insulating effect of the cloud blanket which slowly brought about a colder climate. Such continued cooling with the resultant desiccation over countless ages caused the death of many of the higher forms of life near the poles. The increased snow that could not escape into the oceans piled up in frozen masses as glaciers, which have been very effective in glaciation from time to time due to crustal changes. Life moved equatorward, ahead of such cooling, like the closing diaphragm of a great snapped camera. Continued low temperatures soon left little moisture in the air with the result that sublimation is today moving glaciers polarward all over the world. At the same time, Arctic vegetation was moving equatorward due to the ravages of desiccation, which was brought about by fixation of water as a solid. Ecologists have for a long time believed that the recession of the recent great glaciers in North America was followed by a return northward of forms pushed equatorward by the oncoming glacier. It is true that this has occurred, but only in so far as such vegetation marched in ecological zones to which it was adjusted. Once they reached their limit as marked by the declining solar radiation, they turned about and today are actually receding equatorward before the desiccating climate of a slowly declining earth. It is well known that many plant forms once extended much farther polarward than they do today. The work of many scientists

on bogs has definitely established this fact for epochs, which after all, are but the minor movements in the great symphony of the ages.

That some such ecological succession has paced vegetation equatorward is shown by the records of the rocks themselves as each succeeding layer upward shows higher and higher forms of successions. It is not unusual to speak of such geological ages as that of Algae, Fishes, Reptiles, Ferns, Gymnosperms, and finally the Age of Angiosperms in which we are now living.

At the present moment ecologists know of no form that will replace the Oak-Beech-Maple forests that are to be found in the Ohio Valley, nor that will replace mammals among animals. It is my suggestion that they may be replaced by lower forms of life, just as lichens are replacing trees in high latitudes today, as desiccation continues to sweep equatorward in its relentless march against higher plants and animals. This can be, it would seem, the only fate on a cold earth with a declining sun. If one travels north from the Oak-Beech-Maple forests he will get a picture of the vegetation which will march on to completion equatorward over the vegetation that it here today. In other words, invasion is from the poles not toward them. Extensions and recessions are but minor events in world movements. It would appear that we may have been reading the ecological meter stick of time from the wrong end.

The sun, I believe, will continue to lose heat over millions of years as it has done in the past. The tropics which are dynamic and not static will cool, lose their heat and moisture, and will in turn become temperate, then frigid. The entire earth will slowly become frigid and dry. Instead of from "Dust to Dust," as is said of the earth's organic life, we may say of the earth "from Desiccation to Desiccation," for at the beginning stands heat and at the end, cold. It is my belief that the paucity of fossils in the tropics today is due to the lack of plants to fossilize since they were not present early because of unfavorable climate. Torrential rains could not have destroyed them. They have never been formed abundantly in the youthful tropics.

Another point to be introduced for thought is the theory of perennials. All life, of whatever type, was in the early stages of the earth perennial, continuous, everlasting, dying only by accident. When terrestrial radiation declined to a point where the sun became an effective weapon in producing heat on the earth, the new factor of rhythm of the seasons was introduced into the world. As the sun played along the earth from pole to pole uninfluenced by terrestrial heat, the seasons were born. This rhythm has had a profound effect upon all life. It is my belief that this rhythm has been responsible for the introduction of annuals from perennials. This can be accomplished experimentally today. Annuals today are closely confined to the temperate regions where the effect of rhythm is so pronounced. It is an added link in the proof that trees preceded herbaceous vegetation. Lack of annuals in numbers in the tropics is believed due to lack of pronounced rhythm.

Finally, I believe the annuals, which are recognized as a much younger type of vegetation than perennials, will at last overrun the tropics as rhythm is introduced in a declining earth by cooling. Annual

forms of herbaceous type will invade and take possession to last only until colder climates limit them in the tropics as they do now to the temperate zone. The woody perennials will disappear and will be replaced by herbaceous perennials such as we find in polar regions now. These will finally be replaced in turn by some form such as the lichens which will withstand great desiccation. Tundra will cover the rocks to make a last stand against the closing chapters of what has been a good earth. All will become frozen, dry. This will be millions and millions of years hence, a longer span perhaps by many times than the past history of the earth has covered. It seems reasonable to believe that the life of the earth is not unlike that of any life; namely, a beginning, a growth period, maturity, decline, and death. No other fate seems possible to a declining earth. It seems we can say with surety:

"A time there was when life had never been
A time will be, it will have passed away."