Natural Alchemy of Religious Opinion
Origin and Development of Plants
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Natural Alchemy of Religious Opinion
Part II. Origin and Development of Plants
by C.C. Zain

In this course of lessons I am attempting to present, in briefest possible form, a picture of the progress of existence, according to the findings of science, from the time of primitive star-dust until the development of present-day religion. Yet this is not all that I am attempting to do. In times long past, tradition traces it back to Atlantis, and still- farther back, even to a race of more ethereal people in what is known as the Golden Age.,- at least we have proof they existed in ancient Chaldea and Egypt--there was a class of men, a priesthood: whose lives were dedicated to spiritual things. These men, devoting their lives to spiritual research generation after generation, specialized in religious effort. They claimed to develop their psychic senses by which they penetrated to nature's inmost sanctuary. They organized into a society, or fraternity, the better to cooperate in research and the better to communicate their findings one to another. They instituted ceremonies and conducted initiations. Their doctrines were later called Hermetic Teachings, and the Initiates were called Hermetic Initiates. This western society--designated western to distinguish it from similar societies in India and Tibet--variously organized and variously named in the different languages of the times and countries through which it passed, may be rendered into English as The Brotherhood of Light. And it is my purpose, when presenting this outline of the world's growth up to today to give the present opinion of material science and then at such points as the Old Hermetic Teaching disagrees with modern science to call attention to that disagreement. Now the most generally accepted theory is that the earth at the completion of its growth was in a molten state. After the Moon broke away from the earth the latter had a diameter estimated at 8,100 miles. Since that time it has shrunk in size, partly due to loss of heat, but to a still greater extent due to an internal rearrangement of its molecular structure, until its present diameter is but 7,918 miles. During the cooling the viscous material slowly continued to boil, and as a crust would form, hotter material from the interior would break through and the heavier portions of the crust would sink toward the center. The fact that solid rock does not float on molten rock like ice on water, but tends to sink, is but one argument against the old notion that there is a crust at the present day supported by a molten interior, Undoubtedly the heavier materials would sink to the center of the earth. It has even been suggested that, as gold is one of the heaviest metals, the earth has a core of almost solid gold. This, however, is mere speculations. But from what is known of the weight and density of the earth, and of other celestial bodies like meteorites, it is not improbable that the earth has a core some 4,000 miles in diameter mostly composed of iron. Other metalliferous and basic rocks, due to their relative weight would lie above this iron core: while the acid rocks,: chiefly granites, being much lighter, would rise to the top like the slag of a blast furnace, which is of like, composition, rises to the top of the molten metals It is now quite well established that the continents are built of much lighter material than the ocean beds: the ocean bottom being of basaltic rock some 3% heavier than the granitic rocks forming most of the continents. Some now think that the region of the Pacific Ocean is where the Moon broke off from the earth,

the opposite section of the earth being where the tidal bulge was simultaneously formed on the other side of the earth. This then became the region where the granite frosting floating on the plastic and heavier basalt beneath, like the frosting on a custard pie, was left after the Moon broke out from close to the surface on the other side. And now comes Professor Wegener with a theory that is finding considerable acceptance, that the continents were anciently much- nearer together than at present. Nearly all geologists now believe that underlying the crust of the earth, say some 60 miles below sea level, there exists between the more metalic interior and the outer cover a rather thin layer of basaltic rock. It is also known, because the process has been duplicated in the laboratory, that under the pressure and heat known to exist in the flowage zone-- below about 60 miles depth-- that the rock flows like ice in a glacier, through recrystalization. While still as rigid as steel* it nevertheless flows under pressure without breaking, just as a piece of hard pitch or asphalt may be made to assume any form without breaking by subjecting it to gradual pressure. Yet the same pitch or asphalt or the same rock, if subjected to a quick strain will break like glass. Professor Wegener believes that South America, Antarctica, Australia and India were much once closer to South Africa than at present. In fact, they seem to fit to South Africa when their shore lines are brought together. And in like manner North America seems somewhat to fit to Europe. Certain it is, from the similarity of their flora and fauna, that the continents were connected by land at no very distant date, geologically speaking. Professor Wegener believes that these blocks of granite frosting, floating on the viscous basalt beneath, broke apart in the Tertiary Epoch, and that America drifted westward away from the old world. Such westward floating might naturally arise from the eastward rotation of the earth on its axis, and from other known forces. This proximity of the Old world and the New does not fail to take into account ancient Atlantis, for its existence is well established. ."Whether Plato's description of prehistoric Atlantis-- and the high state of civilization of its inhabitants-- is credible or not, there is little doubt that in very remote times there was a large land mass between the Eastern and Western Continents". (1) Greenland at the present time is moving away from Europe at the rate of 50 feet in a year. The American Continents in their westward movement are supposed to have buckled up the crust toward the West, due to the resistance offered the advancing continental edges. This gave rise to the great mountain chains of the Rocky Mountains and the Andes. Along the western, or advancing, edge of the continents there would be a tendency to many minor adjustments of the floating crust. To the east of the Old Continents, however, there would he no pushing, but the eastern edge would drop off abruptly where it juts onto the heavier basaltic ocean floor. And in reality Japan and the Phillipine Islands rest on the brink of a precipice, the deepest portions of the ocean adjoining them. On the edge of such a precipice, we might expect sections to slide off, or other adjustments to take place frequently. These disturbances, undoubtedly give rise to the numerous earthquakes in the region mentioned. Quite recently Prof. John F. Hayford of Northwestern University and Dr. Wm. Bowie, Chief of the Division of Geodesy in the U. S. Coast and Godedic Survey, have worked out certain facts that help us understand the cause of the rise and fall and buckling of the earth's crust. They have shown that were the earth's' crust cut into blocks 100 miles square and 60 miles below sea level, the various blocks would weigh the same, irrespective of the fact that some containing mountains would have a larger volume. They have proved this both by astronomical and by geodic calculations, and explain that unless such an equilibrium exists the Rocky Mountains would doubtless break down the terrestrial shell. They also point out that the lightening of a block as much as 3% would be sufficient to elevate the mass 9,000 feet. And as above explained the lighter materials are close to the surface, for a weight of a cubic foot of earth at the surface is but 2 1/2 times that of water, while the weight of the entire globe is 5 1/2 times that of water. With a few exceptions, such as the Alabama Hills in Inyo Co., California, practically every portion of the globe at one time or another,. and usually numerous times, has formed at the bottom of the sea. The silt and 'sand then deposited and later compressed into shales and sandstones, or other sedimentary rock, may, after the region has become dry and lifted into a mountain chain, have been removed by erosion leaving bare the granite mountain core. But land areas

in general periodically rise as mountains, to be worn down by erosion and again form sea bottoms. This is due, not only to the possible westward drift of continents shoving up regions toward the front of their movements: and to the shrinkage of the earth causing the crust to become too large and thus wrinkle like the skin of a drying apple, but also do to the constant shifting of weight of the land areas. According to the ideas of Hayford and Bowie, above mentioned, as the mountains are worn down by erosion and carried into the zee, there is an increase of weight in the region where the material of erosion is deposited and a decrease of weight in the region from which it was removed. Now if the load on a raft is moved to one side, that side of the raft sinks and elevates the other side of the raft. Land areas are rafts of rock floating on a plastic ocean of basalt. But there is this difference between them and ordinary rafts, in that the region pushed down below some 60 miles depth becomes part of the flowage zone, melts off the bottom of the raft and moves to some region of .lesser weight, there to push up some other section of the earth. According to the U.S. Geological survey there is delivered into the Seas and Oceans from the United States alone 783,000,000 tons of rock materials every year. It will be seen that as the present mountains are due mostly to a shrinkage of some 200 miles in the diameter of the earth, that before such shrinkage there were probably no mountains. This is born out by much evidence, and there is no doubt but that as time passes and new mountain ranges are formed that the new ones are larger than those of an earlier date. Throughout geologic time lands have gone down as well as ups but the sum of their movements have been upward, and the sea areas have gone up as well as down, but the sum of their movements has been downward. The land is gradually getting higher and the sea is gradually getting deeper. Our earth at the end of its period of growth is thought to have had an atmosphere similar to the present one except that there was very little oxygen in it. Although the oxidation of the rocks has consumed some oxygen, the influence of plant life has steadily been to increase the oxygen content of the atmosphere and make it more suitable for animal life. It has done this by utilizing the carbon and freeing the oxygen of the carbon dioxide gas in the earth's gaseous envelope. This carbon dioxide gas is constantly replenished by volcanic activity. Volcanos which are now thought to be due to local regions beneath the earth's crust becoming overheated through the activities of radioactive minerals, are not unmitigated evils as they are generally regarded. Instead of being vents through which the molten interior of the earth flows, they are vents for molten pockets of rock that have become intensely heated by radio-activity of minerals in particular regions. And they contribute carbon to the atmosphere. Carbon is one of the three fundamental materials at the basis of life, and were there double the life on earth that there is at the present time, all life would cease; for all the carbon in the atmosphere would be in the bodies of plants and animals, and death would overtake all. Further, should volcanic activity cease it would not be long before the existence of life would be impossible because of lack of carbon. (2) The water also, so the newer geology teaches, came out of the earth as the earth cooled, through volcanic activity and warm springs. Much of it was added, there is good reason to believe, in later geologic time. Thus the waters of the ocean tend to encroach upon the land, even while the water falling from the sky wears down the mountains and carries them out to sea. Two mountain ranges in North America, bigger than the rockies, were lifted up and then worn down by such agencies before the present mountain ranges were lifted up. Sand and clay and mud are all the products of rock worn down by frost and wind and rain and glaciers. From the depth and size of such sedimentation can be calculated with much accuracy the size of the mountains required in their formation. The water constantly tends to wear down and deposit land areas in the seas and Sir Archibold Geikie calculates that if the continents were thus deposited in the sea the sea level would be raised 650 feet, and if North America remained stationary half of it would be covered by the sea to a depth of several hundred feet. Yet while there is a periodic rise and submergence of land areas it is not now thought that the ocean beds were once land. Schuchert says--"But the newer geology no longer holds to the theory that the oceans and lands have repeatedly changed places; quite the contrary, we agree with Dana that the present positions of the land and water areas have been more or less permanent throughout geologic time."(2) Small warpings of the earth's crust are

going on all the time due to the shifting of the weight of areas through sedimentation. Such warpings usually elevate local regions only a few hundred feet. Erosion continues on a continent until the land area is but little above sea level-- a condition which has prevailed during most of geologic time-- and then, as Hermetic students believes there comes a time, determined by astrological tensions, When the crust yields to the strain of shifted weight and slowly, near the margins of the continents, the crust folds and breaks in the formation of ranges of mountains from 1,000 to 1,500 miles long. These are called "Minor Crustal Adjustments", and at least eight are known to have occured in North America. At still greater intervals-- determined according to the Old Hermetic Teachings by astrological conditions-- there is a more complete adjustment of the land areas the world over. As the result huge mountain ranges are formed and the continents are elevated to a much greater height above the ocean level. 'These are called "Major Readjustments", and at least six are known to have occured during geologic time. The elevation of such huge masses of land has a decided effect upon the climate. New land areas change ocean currents, new mountain ranges change air currents, and even as now it is cold on a mountain tops so excessive elevation of land areas causes the climate to become so cold that the snow does not melt as fast as it falls. The mountains first become covered with glaciers, and these lowering the temperature of the surrounding territory tend to spread the glaciers until a continent may be covered with an ice sheet from the north down to a latitude Where melting takes place faster than the snow falls. Geologists know of seven periods in the past-- each following a very long time of warm climatic conditions--when there were decided coolings of the climate, at least four of these periods being glacial. I have not yet spoken of life upon the earth, but a moments reflection will indicate what a terrific effect upon life that had been living in a warm climate there would be if the land areas rose to great height, causing a glacial winter to set in lasting for thousands of years, causing the seas to deepen yet decreasing their areas and thus crowding the life in it for room, causing swift running torrents to flow from the rugged land where before there had been but sluggish streams, shutting off moist winds from certain interior regions and making them arid, and in a dozen ways upsetting the conditions that life had become accustomed to. Whatever forms of life had come into being upon the earth had for millions of years adapted itself to the wide warm shallow seas, or to the broad expanses of low lying and swampy lands that held a tropic, or temperate climate as far north and south even as the poles. Picture then the effect upon this life of one of these Major Readjustments. The most successful life-forms had been specializing along lines that would meet the previous requirements, and many of them had become so successful that they grew to enormous size and were undisputed masters of wide territories in land or sea. But they were utterly unfitted for the new conditions by which they were not confronted. In fact, the more they had specialized, the more they were fitted for the previous conditions, the less fitted they were for the new one. Specialization is always-- except when intelligence is the specialty--at the cost of general adaptability. As the result` of the new climatic and topographical conditions extensive migrations of life take place in the attempt to find a more suitable environment. The huge and overtrained masters of wide sections of the globe, unable to survive under the rigor of the new climate, perish from the face of the earth. Other life-forms, small and hitherto of little importance in the world's struggle, yet possessing adaptibility, successfully adjust themselves to the new conditions, and in the course of ages multiply in number and increase in size until they become the dominating forms.- A few of the older forms of life are pushed into the less desirable corners of the world and inconspicuously survive, living to the present day as reminders of a vanished past but most of the unadaptive families of life become extinct* and we know of them only by their fossil remains. So far as known, at the present time all living things come from previously existing living things through some method of reproduction. Biologists are not agreed whether the first life on earth had its origin here, or was carried here from some remote sphere*, as a spore or seed imbedded in a meteoritic fragment. They are quite agreed, however, that sometime,- somewhere, in a manner quite incomprehensible to them, highly complex and unstable inorganic compounds became possessed of life. The Old Hermetic Teaching is that

intelligence inheres in all grades of substance and under the stimuli of astrological forces ever tends to express this intelligence in a more complex' form. Minerals, when alive, are the vehicles, of bodies, of evolving impersonal souls.- These, having had experiences in mineral form, after a period of assimilation and progress in the astral regions, are drawn again by their desires to a physical planet for experiences of a higher order. This intense desire to express in a higher form of life, acting upon the inherent intelligence of the mineral kingdom, after a time, when astrological conditions offer additional stimulus in this direction, are able to bring together the inorganic elements in proper proportions and to incarnate in them as a vegetable form of life. Inorganic matter becomes organic substance through the intense,- yet subjective,' desire of an evolving soul to find a fuller avenue of expression Organic life probably first appeared upon the earth at a time when the temperature was considerably higher than now and at a time when there was little free oxygen in the atmosphere,- and while the sunlight was shut off by dense clouds. It is estimated that there is in the sedimentary rocks and in the fuel deposits of the earth, 30,000 times as much carbon as there is at present in the atmosphere.(2) Higher forms of life could not live under such conditions as doubtless existed when all this carbon as carbon dioxide gas was in the atmosphere. Together with water vapor it must have formed an atmospheric blanket that absorbed the rays of the sun and kept the heat of the earth from radiating. Under these conditions, bacteria, the lowest form of life of which we have any knowledge would thrive and prosper. Plants are dependent upon light for the assimilation of the carbon dioxide of the air, which is their chief and most essential food supply. The nitrogen bacteria, which unlike plants,- in so far as has been discovered, have no cell structure, and thus are the simplest forms of life,- have the power of assimilating free nitrogen from the air and at the same time and without the aid of sunlight can decompose carbon dioxide, They' thus can live on inorganic products without the aid of sunlight, which plants are incapable of doing. All life on earth-- bacteria, plants, animals, and man-- is associated with protoplasm. The four most important elements in protoplasm are nitrogen, carbon, oxygen and hydrogen* which the primitive bacteria obtained from the free nitrogen, the carbon dioxides and the water, of the air. Among the oldest rocks of the earth formed after the process of erosion set in-- and geologic time is the time measured by the products of erosion-- there are to be found immense deposits of mineral that have been formed by other bacteria which have developed from the simpler form. Iron bacteria obtain their energy from the oxidation of iron compounds, the iron oxide so obtained, being insoluble, remains in the bacteria, and when the bacteria dies this iron oxide remains as a mineral deposit. Vast beds of iron ore, formed in this manner are known. Sulphur bacteria in a similar manner oxidize hydrogen sulphide, and the remnants of their dead bodies form huge ancient mineral deposits. Life was not content, however, with any such primitive existence. There was the urge for more complex expression. And this desire in the course of time produced an alteration and development in form. Certain of the blue green algae, which are plants, occur as slimy blackish green films. They, like the bacteria, reproduce by simple cell division. Some of them, similar to bacteria, are able to endure a heat that would be fatal to ordinary plants. The sinter deposits, or formation, of the hot springs and geysers in Yellowstone Park are due to such algae. So also in cooler water the presence of a free floating form of blue green algae, so called but in this case red, gives to the Red Sea its characteristic color. The development of the first plant was a decided step in the progress of life. Green plants have attracted chemical elements in such proportions as to manufacture chlorophyll, which is the substance that gives to leaves their green color. This chlorophyll, in the presence of sunlight has the property of capturing carbon from the carbon dioxide in the atmosphere while releasing free oxygen. The process by which it does this is similar to that by which sunlight causes chemical changes to take place on a photographic negatives and is called photosynthesis. While some of the bacteria in the world today are injurious to mankind, through leaving their by-products where they poison him, yet organic life is dependent upon bacteria for continued existence. Bacteria not only assimilate free nitrogen, and change certain nitrogen containing substances in the soil into forms that can be used by higher plants, but they bring about the decomposition of dead organic material, which is

essential if it is to be used by plants. All organisms give off waste products, but with the exception of carbon dioxide little of this waste matter can be used by plants until it has been decomposed, or rotted, through the action of bacteria. Animals are entirely dependent upon organic food for their existence, for they are not provided with chlorophyll. This organic food is supplied by plants. There are some plants also, like mushrooms, molds, mildews and rusts, as well as certain flowering plants, that have no chlorophyll. They, therefore, depend upon the organic food which has been gathered-- that in some cases has decayed through the action of bacteria and in others yet exists in the living plant--for their food supply. So, while bacteria are essential for the proper circulation of food elements, plants actually manufacture all organic food. The early plant, consisting of but a single cell, needed a certain amount of protection, and this desire gave rise to the formation of a cellulose wall about the protoplasm within. The protoplasm in all but the very lowest plants, even as is true in all animal cells, contains a well organized nucleus. Growth in plants and animals alike takes place through cell division in which both the nucleus and the surrounding part of the protoplasm split, a portion of each going into the production of new cells. The protoplasm in the body of man today undoubtedly contains an infinitely small amount of the protoplasm of a primitive one celled form of life that existed hundreds of millions of years ago, for so far as has been observed new cells are formed only by the division of cells previously existing. It is evident that in many cases if a group of cells were to work in harmony it would be an advantage to all. So next on the scene of world progress we find instead of single celled plants, plants composed of a number of cells. The simplest of these are the filamentous algae, consisting of rows of cells somewhat like a chain, barely attached to one another. When such a colony of cells finally became established, the next step would be toward a division of labor, and we find a tendency in somewhat higher forms of algae for certain cells to specialize in gathering carbon from the air, and others to specialize in the storage of the food so gathered, and still others in protecting it from the evaporation of its water, and from the inclemancies of its environment. Before we pass to the still further development of plants of more than one cell it will pay us to pause a moment in awe before the vast work of the primitive algae that early in the geological history of the world must have literally swarmed the seas. We are somewhat familiar with the work of coral, which build islands and shore lines with their dead bodies, but such land building does not compare in its extent and importance with that of certain lime secreting algae. These calcareous algae, as they are called, are held to be responsible for the formation of the very ancient limestones. The rocks of the Grenville Series alone, a very ancient series of rocks, are nearly 18 miles thick, and half of this is limestone undoubtedly deposited by such algae. In other cases the algae and a lime secreting bacterium are jointly responsible, as in the case of the massive limestones of the Teton region. This habit of secreting lime, which was later adopted by animal life, has a most important bearing upon any study of the past, for before this neither animals nor plants had hard parts that could be preserved as fossils in the rocks, and their presence can only be known from inference. Such an inference as to the ancient extent of life on the earth may be found in beds of iron ore and sulphur as previously mentioned, and in the existence of masses of graphite in exceedingly ancient formations. Graphite is never produced in nature other than through organic activity. (2) Most of us are familiar with green "pond scums", which are chains of algae cells, all quite alike, floating on the water. These are fresh water algae, but certain kinds that have developed from them, and become more elaborate in structure have found their way to the sea and form the green sea weeds, and others, because they secrete lime, look very much like plant corals. The bulk of marine vegetation, or seaweeds, however, have developed other traits to suit their salt water environment and belong to either the Brown Algae or the Red Algae. The Brown Algae, including the giant kelps which are so common to the Pacific Coast of America and so familiar to those who visit the beaches near Los Angeles, sometimes reach a length of one hundred yards or over. They are probably not direct descendants from green algae, but from certain other primitive organisms known as Flagellata, from some of which both the higher plants and animals seem to be descended. The Red Algae, which constitutes a greater bulk of the seaweed is thought to be but a more

complex development from green algae. The red pigment and the brown pigment, by which these plants are colored, is supposed to suppliment the action of the chlorophyll in utilizing the light that filters to it through the water. The ancient seas were fresh, for the salt now in the sea was gradually leached out of the land. The adaptation of life to salt water, then, is of a later date than the more ancient rocks that have been formed by sedimentation. The giant kelps and the red algae, above mentioned, have solved the problem of living in salt water better than any other plants, and seem to have reached a point, due to the restrictions of their environment, beyond which further progress is impossible. Their texture is such, due to the manner in which the cells join, that While immersed in water it freely circulates through them, yet the outer cells have been thickened and toughened to form a leathery skin which, when exposed to sun and air, due to low tides, protects it from evaporation. some of them, like the giant kelps, have developed not only an anchoring device, called a holdfast, by which one end is attached to a pebble at the sea bottom, but also hollow bladder-like buoys that may be as large as a child's head, by which their long stems, bearing floating leaves may be made to reach the surface. It is supposed by some naturalists that the fungi are descended from certain species of red algae. The fungi do not possess chlorophyll and depend upon other plants and animals to furnish their carbon food supply. They probably have degenerated from higher plant forms, finding an easy living at the expense of others. Parasitism, whether in plants, in animals, or if we may use the term thus, in man, is always followed by deterioration. These fungi-- the molds, mildews, rusts, mushrooms, etc.-- some 40,000 species of which are known-- have degenerated to a very low level in plant life. They do not possess seeds, but propagate by means of spores. .The smoke that issues from a puffball when pressed, consists of millions of such spores. In the case of the familiar mushrooms and toadstools the spores are developed in the gills on the under side. In fact these gills, or flutings, open for the express purpose of dropping the myriad minute spores by which they reproduce. Fresh water ponds are in the habit of drying up. In such instances the green algae living upon their surfaces, unless possessed of some method of tiding over the dry spell, all die. The mud at the bottom of such a pond, when the pond first dries: is moist, and the algae would cling to it for moisture, for active life either in plants or animals depends' upon the protoplasm being supplied with moisture. The water gives to protoplasm a semi-fluid consistency which is absolutely essential to its movement. The green algae, resting upon the drying bottom of a pond, would be hard pressed to prevent all its moisture being dried out by the Sun, and to get an additional supply from the drying mud. The desire for life-- a subjective desire, but a yearning: nevertheless so Hermetic Students believe--brought a response in the nature of structural changes. The algae, by a thickening of the cell walls, escaped being completely dried up, and thus when the dry spell was over was able to resume life. These special thick-walled cells, which foreshadowed the development of seeds, are called resting spores. Some of the algae, also, in its desire to follow the water as it receded into the mud, and thus provide itself with moisture: developed cells in the direction of the moisture, and these cells becoming specialized were the first roots. This was one of the greatest and most important steps taken by life since it started on our globe, for it gave rise to the ability of life to live upon the land. Vegetable life in the water depends upon the water for support, but when life crept from the warm and shallow ponds and fresh water seas out upon the land it found it to be a great advantage to be able to lift its chlorophyll-bearing surface to the Sun that it might draw a greater food supply from the air. Some of the liverworts, which lie prostrate upon the ground: have delicate hair-like roots, and a structure not as complex as some algae-- being composed of almost uniform cells. They live today as examples of what the first land plants must have been like. But with the desire strong upon them to reach the light, certain of the cells developed e harder more compact structure, and gradually a supporting stem cane into being. With the development of firm supporting tissues the need arose also for special tissues for the rapid transportation of water, and a softer conducting tissue was developed. Not only are the liverworts prostrate, but so are some of the other low land plants such as the mosses. And to indicate that their ancestors came from the water we find that mosses and ferns are dependent upon the presence of free water for the development

of certain phases of their life histories. Even as amphibious animals must return to the water to lay their eggs, and pass through the early stages of life in water, so familiar to us in the lives of frogs and toads as the tadpole stage, so these plants also nay be considered amphibious. The ferns, although reproducing by means of spores instead of seeds, are more complex in structure and in their life-histories than the liverworts and mosses. A spore is a single cell, minute in size and without sex, and in the case of the fern a number are born in each little capsule on the under side of the frond (leaf). When this spore is released and germinates it does not grow into a fern, but into a very different plant, or prothallus, a green blade about a. quarter of an inch long. On the lower side of this new plant grow the sexual reproductive organs which produce the egg-cells and sperms. The sperm has a tail of minute hair-like cells by which it swims through the film of water that must be present on the blade of the plant, to the egg, which it enters and impregnates. And from this the new fern grows. In the case of the mosses the generation that produces the sexual parts is the moss plant, the other plant essential in the life cycle being the capsule Which bears the spores. This lives as a parasite on its parent. Spores are not seeds, but they serve as resting bodies through which later a generation may be perpetuated, and they serve as a convenient means of distributing the species. Somewhat more complex than, yet evidently related to, the ferns are the curious horsetails that grow on low moist ground. Some twenty-five species are known to exist at present, representing, in a meagre way many gigantic species that once existed upon the earth before the advent of flowering plants. The club mosses: also spore bearing plants: are supposed to be related remotely to the ferns, and once provided an important part of the land vegetation. The dependence upon water for the propagation of the species became a serious handicap to land plants* just as it did to land animals, and the problem was solved much in the same way by both. In the case of a seed plant the pollen falling on the ovule develops a little tube that penetrates the egg and brings the fusion of male and female elements that are necessary for the beginning off' a new plant. This does not require the presence of water through which the sperm must swim, and has an additional advantage in that the young plant resulting Prom the fusion of male and female elements remains associated with the parent plant drawing nourishment from it, and protected from inclemencies by being inclosed in a sheath and surrounded by nourishing food. When the- little plant in the seed reaches a certain stage of growth its development is stopped for the time being, to begin again when the plant has left its parent and found its way into moist soil. Seed bearing plants release their young alive, quite as effectually as do the higher animals. The young plant, or embryo, which can clearly be seen by opening a soaked pea or bean, has another great advantage over the plants growing from the sexual union of the parts that grow from a spore. The latter must procure all their own nourishment from the start. But seed plants have an abundance of food stored up in the seed to give them a good start on life's journey. They are as well provided for as the calf which grows inside its mother from an egg to considerable size before being born, and then after birth is provided with rich warm milk for six months or more. The seed plants take excellent care of their young. The first seed plants were ferns, now extinct but existing in great numbers during the Paleozoic Era, These seeds were less perfect than those of today, and no fern now exists that bears seeds. The cycads and ginkgos, once very numerous upon the earth, are clearly descended from ferns, and represent no great modification in structure. The "sage palm" of our greenhouses is one of the cycads, and the Ginkgo, or maiden-hair tree, is quite common as an ornamental tree here in California. It is thought that the conifer, or cone-bearing trees, are modifications of certain club mosses whose fossil remains have been discovered. A small species of club moss is common on the hills of Los Angeles. The cones seem to be mere modifications of structure common to certain extinct club mosses which are known to have born seeds. These cone bearing plants, represented most extensively by our pines and firs, are of a lower order of existence than most of our flowering trees and plants. The thin long resenous foliage of our conifers is an adaptation to prevent the excessive evaporation of moisture from the plant in dry regions. Other plants of the same group, such as the Araucaria which is common in California Parks, have broader leaves. These trees came into existence upon the face of the earth at a much earlier date than the

common flowering plants. The seed, instead of being inclosed in an ovary is naked, like those of the cycads, and is born on the surface of a scale. These scales, bearing naked seeds on their surfaces, form the cones of such trees with which we are so familiar. Even though the conifers came into existence so long ago, they have proved exceedingly successful as our vast northern forests prove. Some of them, too, have developed an uncanny way of anticipating the future, as in the case of fire-typepines, which hold their seeds for a dozen years until a fire destroys all the other vegetation, and then, due to the heat that has passed, the cones open and the seeds are deposited in the ground that has been well prepared for their being covered, and from which the competition of other growth has been eliminated.

(1) The Outline of Science: by Prof. J. Arthur Thompson, Vol IV. page 924.

(2) Earth's Changing Surface, by Charles Schuchert, Prof. Paleontology, Yale.

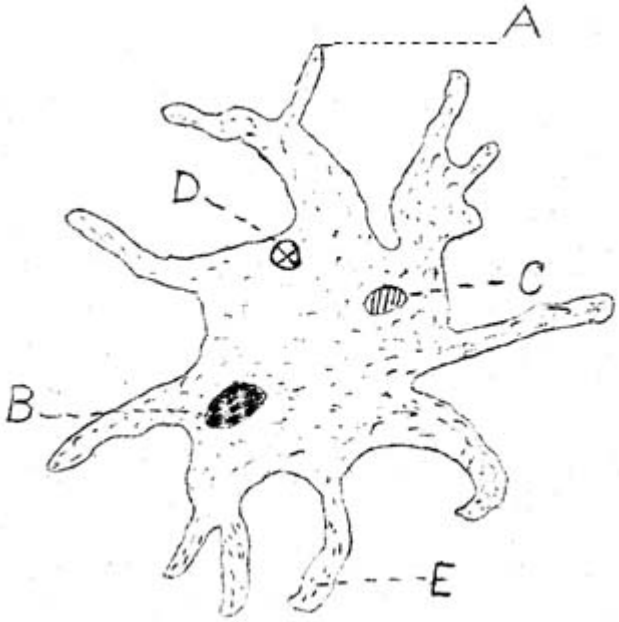

DIAGRAM of an AMOEBA

The amoeba is a typical Protozoon. It appears as an irregular speck of greyish jelly about 1/100th of an inch in diameter. It is common in fresh water ponds where it oozes along, engulfing other tiny specks of organic matter by flowing over them. A, represents one of the outflowing lobes that surround prey, B, is the nucleus. C, represents food that has been ingested. D, represents undigestible pieces of food that are about to be expelled. E, points to the granular structure of the protoplasm.