DNA Decipher Journal | November 2012 | Volume 2 | Issue 3 | pp. 280-290
Campbell, R., *Part II: An Intelligent Face to Evolution: Plant - Exploring the Spatial Forms of the Eukaryotic Cell*

Article

Part II: An Intelligent Face to Evolution: Plants – Exploring the Spatial Forms of the Eukaryotic Cell

Robert Campbell *

ABSTRACT

Biological evolution follows four levels of development that are progressively delegated toward the emergence of sentient awareness with an increasing step-like capacity to span and integrate events extended in space and time. Plants store the suns energy in an increasing complexity and refinement of Forms. Invertebrates explore Routines of sensitive response. Vertebrates reflect patterns of behavior in conscious Knowledge. Humans can create new Ideas while remaining anchored to lower levels in the four level hierarchy: Idea, Knowledge, Routine and Form. The four levels subsume four self-similar levels within each level such that they are evident within the context of plant evolution as shown in this article with interdependent interplay between all levels in the hierarchy as higher levels emerge. Single celled and multi-celled plant Forms were followed by plants with vascular Routines that allowed them to reach for the sky. The appearance of seeds in gymnosperms demonstrated Knowledge of processes extended in space and time and liberated them from a swampy environment. The flowering plants were essential to the Idea of evolving more sentient life forms in the mammals and birds by providing concentrated food to support their higher metabolic rate. This self similar four level pattern pattern within each level of the hierarchy is explored in successive articles.

Key Words: Cosmic Order, evolution, intelligence, historic integration, idea, knowledge, routine, form.

Form-form:

This first level in the universal hierarchy includes primitive plants, consisting of the huge variety of algaes, from microscopic unicellular varieties to giant kelp (apart from the cyanobacteria, often called blue-green algae, but which are in fact photosynthetic bacteria). Also included in this *form-form* level of plants are the fungi, slime molds, and the lichens.

Fungi will be considered as an involutionary variant of early plants that subsequently evolved in parallel with them. Fungi cannot photosynthesize the nutrients that they need so they are dependent on green plants for food. But their spores are everywhere, growing whenever they find a food source such as dead plant life, and they assist the decay of organic matter through their digestive processes that extract the energy they need. They provide a vital function in this involutionary process of decay. Most fungi are thus benign saprotrophs utilizing the waste of evolutionary variants, but some are parasites on living plants and animals.

---

* Correspondence: Rober Campbell, Independent Researcher. Website: http://www.cosmic-mindreach.com
E-mail: bob@cosmic-mindreach.com

Note: The articles presented in this issue are based on my book "Downsizing Darwin: An Intelligent Face for Evolution" self-published in 1996 [1]. More information is available at my website [2].

The algae, in parallel with the fungi, explored the eukaryotic format, predominantly in the sea and fresh water lakes and streams. Small simple forms first began to pioneer on land about five hundred million years ago. The simplest unicellular forms of algae reproduce by cell division with more complex forms developing alternate sexual and asexual generations, called the gametophyte and the sporophyte Both sexual and asexual reproduction of some kind generally occurs in algae.

The reproductive processes of fungi are considerably more varied, especially since the mycellium or body of many fungi is not partitioned into separate cells, but consists of branching hyphae, or filaments. These filaments grow at their tips, like a maze of intertwined tributaries, to form the body of the fungus. The cytoplasm circulates nutrients through the mycellium which may have many nuclei containing different genetic material. Two groups of higher fungi, the Basidiomycotina, such as toadstools, coral fungi and fairy clubs, and the Ascomycotina, such as morels and truffels, produce elaborate fruiting bodies made up of a mass of hyphae that rise like a crown above a base.. They pioneered the classic root-trunk-top structure that is so typical of terrestrial plants, but without highly differentiated cell types employed in their separate organs.

Fungi generally lack cellulose, a common component of cell walls in green plants, and many use chitin instead, a component also found in the exoskeleton of arthropods, such as insects. The algae store food in a variety of starches, polysacharides and oils, while fungi never use starch.

As pointed out in the last chapter, biologists have difficulty clearly classifying some organisms, especially single-celled creatures. For example the unicelled Euglenida photosynthesize energy from the sun, just as plants do, but they also swim with a tiny tail and have a mouth and gullet to ingest food. These tiny one-celled creatures cannot survive by photosynthesis alone. They also eat. Cells of this general kind are often called protists, or protozoa, since they have characteristics that are both plant and animal. Fungi are also sometimes classified as protists rather than plants, however they are considered as an involutionary variant of plants for our purposes here.

For our purposes at present we may consider protists that use photosynthesis under the general umbrella of plants, even though they may swim, have a mouth, gullet and eat. They emerged at a point early in evolutionary history where animals began to diverge. Sublevels of delegation such as these are comparatively limited in kind and they are generally associated with transitional stages between levels.

We shall see that it is a common feature of evolution for higher levels to begin diverging in the early stages of a previous level, and only begin diversifying widely at some point considerably later. We shall point out examples of this pattern again and again.

Protists or protozoa that do not use photosynthesis and that are motile and ingest food will be considered animals. Amoebas and most of the ciliates are examples. The common paramecium is a single-celled ciliate that uses the many hair-like cilia covering the cell surface to swim.

The life cycles of algae generally show great variation and all algae types, except red algae, have flagellated motile cells at some stage in their life cycles that are much like some of the swimming protists.

Eukaryotes have explored an enormous range of size at the *form-form* level. Some one-celled fungi are only about ten times larger than bacteria, while some algae produce giant cells. The Mermaid's Wineglass is a single cell about 7 centimeters long with a single nucleus and some multi-nucleated cells may become much larger. Brown, green and red algae have explored many diverse forms, including sheet like leaves, filaments, hollow tubes, bushy branched types, stalks with branchlets of many kinds, in a vast array of shapes and sizes. The largest seaweeds, brown algae and kelp, have highly developed multicellular structures, some that are fifty meters or more in length. A group called the diatoms, golden-brown and yellow-green algae types, have a rigid cell wall consisting of pectin impregnated with silica and they are generally restricted to single cells or loose colonies.

Lichens consist of two organisms in an intimate partnership, namely a higher fungus and an alga (sometimes a cyanobacteria takes the place of an alga). The alga is entrapped in the body of the fungus but is allowed enough light for photosynthesis. The fungus thus feeds on the alga and the two grow and reproduce together, although the algae can get along quite well on their own.

Slime molds are especially strange. They are unlike either fungi or algae, although they are closer to fungi. They come in two types. One type flows as a single mass of protoplasm over decaying plants and trees, devouring microorganisms and plant matter. This protoplasmic mass, called the plasmodium, resembles a single cell containing many nuclei. When conditions are right it produces a fruiting body that rises on a stem and releases spores.

The other type of slime mold has no plasmodium and spends most of its life cycle as a proliferating collection of single cells just like amoebas, engulfing food and dividing. As food supplies dwindle the amoebae cells congregate into a mobile slug-like mass, called a pseudoplasmodium, that can respond to heat and light and move, just like an animal. Once this slug-like collection has found a suitable place to its liking, the cells at the head end form into a stalk that rises from a base, to elevate cells at the top. The fruiting body at the top then develops into spores for dispersal, just as in the classic base-trunk-top structure of many plants. For our purposes here slime molds will be considered an involutionary variant of plants, similar in this respect to fungi, since they facilitate the process of decay.

There is clearly a certain capacity at this level to span space and time in working out the spatial forms of the eukaryotic cell and its development in time, from swimming protists, to slime molds and fungi, to giant kelp.

The evidence indicates that divergence to the animals took place from this most basic functional level of the eukaryotic cell, from the single-celled protozoa, and not from more highly evolved levels in the plant kingdom. We shall see repeatedly that each higher level tends to diverge from the early stages of a previous level. It is a recurrent pattern. The emphasis here is on the task cycles of plant cells rather than on product cycles of host plants with highly differentiated organs.

It is apparent that this *form-form* level of plants explores a vast range of size, shape, and type of eukaryotic cell and its processes, including energy acquisition and storage, reproduction, and an immense array of multi-cellular forms. This level generally lacks a developed vascular system associated with integrated circulation routines for the whole plant. It requires an aquatic or very moist environment, apart from a comparatively few small algae, fungi, and lichens.

***Form-routine*:**

The routines essential to evolving higher plant forms on land required the development of vertical support with an efficient vascular system to transport nutrients between roots, trunk and top structure. This overall vascular integration of plant structure required convergence to common reproductive routines also. Vascular systems were essential to the distribution of nutrients within land plants destined to rise fifty meters and more into the air.

However, before vascular land plants could get started plants first had to colonize the land. The first true pioneers were probably the liverworts, hornworts and simple mosses that grew in moist shaded areas near water. They also developed rhizoid type structures to absorb nutrients from soil, short stalks with thickened cell walls for a degree of support, and leaf-like structures.

The earliest vascular plants appeared over four hundred million years ago, during the Silurian period, and they developed throughout the Devonian period. The first forms were small leafless stems lacking real roots. Ancestral mosses elaborated with root-like and leaf-like structures, while the club mosses, horse tails and ferns built on the scheme. These ancestral plants took their leap for the sky at the end of the Devonian and during the Carboniferous period, from three hundred and fifty to two hundred and eighty million years ago. Tree sized versions, forty meters or more high, proliferated in abundance in extensive swamp lands before they became almost completely extinct, with only small modern versions remaining among the horsetails and club mosses.

Up until five hundred million years ago the Earth had not yet been colonized to a significant extent by plants. It was essentially a vast desert during the first great convergence of the continents into a single super-continent. The first land pioneers near lakes, streams and bogs were probably little more than collections of algae-like cells with root-like projections beneath them and upright spore-bearing structures protruding from their upper surfaces. The liverworts, hornworts and mosses that followed elaborated with similar features.

The cells of the spore bearing structures are fundamentally different from the cells of the main body of the plant. The spores have only one set of chromosomes while the main cells of the body have two sets. The spores are said to be haploid rather than diploid. Cell division of a type that produces four daughter cells, called meiosis, precedes spore production, as it does in algae.

The spores then germinate asexually to produce a new haploid gametophyte generation of the plant with only one set of chomosomes. The sexual gametophyte generation of mosses and liverworts requires a sperm to swim to an egg, so these plants must stay close to the ground in moist habitats, to produce in turn the sporophyte generation again with a diploid set of chromsomes. Haploid spores are then released from elevated stalks to promote dispersal in the wind.

This alternation of two generations is a common feature of all terrestrial plants, although in the flowering plants the gametophyte generation completes its short life within the tissues of the sporophyte generation. The point is that all future variation in the reproductive routines of terrestrial plants became confined within these fixed constraints, allowing also for vegetative reproduction from new shoots in many cases.

As plants colonized land by this reproductive pattern, they turned their focus to developing vertical support which required a vascular system to transport water and nutrients. One of the first pioneers over 400 million years ago, was a plant called *Cooksonia*. It had developed specialized fiber-like elements in its stem, called xylem, which were the forerunners of wood. These tube-like elements contain lignen for support and can also be used to transport water through their capillaries, since they are dead and contained within a dense layer of protective outer cells.

By 50 million years later, toward the end of the Devonian period about 360 million years ago, this support and conducting system was reaching for the sky. The giant club mosses and horsetails proliferated in swamp forests to heights of 40 meters or more, forming the coal beds of the earth with their abundant remains. The present day descendants of horsetails reach heights of only three feet, the club mosses only one foot. The ferns, with compound fronds radiating from a stem or trunk, also evolved during Devonian times. The tree ferns, up to sixty feet or more high, have survived to the present day, along with many smaller fern varieties.

One species of surviving club moss, *Selaginella*, produces both male and female spores from separate spore producing organs called sporangia. Instead of germinating when they are shed, the female spores develop haploid tissue within the spore, where they produce egg cells. The smaller male spores release swimming sperm which must find and fertilize the eggs. This separation of male and female gametophytes, and their contraction in size and duration is a significant development for the reproductive routines of subsequent plant evolution.

The reproductive and vascular routines of plants which developed together at this *form-routine level* in their history concerned the integrated organization of more specialized cell types within the whole plant. This emphasized *product cycles* of the host as opposed to the collective *task cycles* of cells. It focuses on product *routines* of the whole plant, rather than task cycles associated with basic cell *forms*. As we shall soon see, this development anticipated evolutionary events to follow that incorporated the knowledge gained by specific routines of plant growth in a more refined and coherent manner. It works much like the evolution of a company from the *supervisory routine* level to the *administrative knowledge* level.

The focus at this *routine* level of *form* is on prioritizing the commitment of available resources to specific *routines* of reproduction, support and vascular circulation within the whole organism. This is similar to the supervisory level of work where available resources must be appropriately distributed for a variety of tasks. Plants re-explored the limits to size within this context.

Form-knowledge:

The collective knowledge gained by early vascular plants and their reproductive methods was reformulated into more refined versions that replaced them by the end of the Carboniferous period. Some two hundred and eighty million years ago the gymnosperms appeared, including the cycads, gingkos and conifers.

The gymnosperms, especially the conifers, liberated plants from a dependence on wet swampy terrain in their gametophyte generation. They did this by developing the pollen grain and the seed. Seeds took over the task of dispersal, in the fern as well as in the gymnosperms which eventually outpaced them.

Both had an ancient origin typically diverging comparatively early in the development of the previous level. The gymnosperms were thus slow to capitalize, replacing ancient forms only after a hundred million years. Yet they integrated the knowledge accumulated by ancient giant forms of horsetails and club mosses and capitalized on it. They were thus able to incorporate features of the *form-routine* level that emerged subsequent to their divergence. It was not a gradual linear development of progressive DNA survival according to Darwinist rules.

Knowledge became manifest in more refined organs generally, not only in sexual reproduction but also in woody vascular systems, and a variety of hardy leaf structures in the conifers. More refined organs became more independently formed, such as highly structured needles, cones, bark and branches. These distinctively integrated plants of many species thrived for another two hundred million years, into the late Cretaceous period. This includes many that have survived to the present day, such as the pine, spruce, cypress, hemlock, and so on that we are familiar with, especially in colder climates.

The mosses, horsetails and ferns at the *form-routine* level depend upon a wet environment for sexual reproduction in their gametophyte generation. This seriously restricts them as land plants. The development of the pollen grain and the seed in the sporophyte generation integrated knowledge of many factors extended in space and time to overcome this restriction in a much broader context.

The first step was the production of separate male and female spores, as in the club moss *Selaginella*, producing separate male and female gametophytes. The gametophytes had to be protected from drying up, however, if they were to survive in drier terrain. This required protection which was provided for in the conifers by retaining the female on the sporophyte generation securely wrapped in tissue. This meant that the male gametophyte had to travel further, often in a horizontal direction. The male gamete also had to penetrate the sporophyte tissue protecting the female egg cells. The pollen grain constituting the male gametophyte thus had to be small enough to be carried on the wind, and likewise encased in a waterproof covering. So these modifications required knowledge of weather processes and how to exploit them by methods extended in space and time beyond the plant and its current environment. It can not be explained by random mutations since parallel mutations acting in concert are needed to meet many parallel needs. No process of selection pressure to promote gradual random changes can be demonstrated.

Conifers have male cones carrying microsporangia (pollen sacs) and female cones carrying megasporangia (nucelli), producing pollen and eggs respectively. Many diverse and complex factors had to be biochemically incorporated for this to happen. Could it really have happened gradually by a long series of accidental mutations?

When a pollen grain is carried inside the female cone it is drawn to the nucellus by a drop of extruded fluid. One of the cells in the pollen grain grows through the nucellus to produce a pollen tube reaching down into the egg. The sperm cell from the pollen grain then passes through the tube to fertilize the egg. The fertilized egg develops into an embryo of a new sporophyte generation inside a covering of nutritional material provided by the gametophyte generation. This gives the new sporophyte a start when it is seeded in a new location. This whole process is slow, taking two years in some cases. The outer coat of this seed is derived from the old sporophyte generation. Repeated complex sets of mutations are required for these developments to happen.

Since the task of dispersal now falls to the seed they sometimes develop wing-like appendages to help them travel on the breeze. How did a detailed wing structure happen by accident without some sort of feedback to inform the plant?

In the junipers, the cone scales swell into an edible covering attractive to animals and birds which transport the seeds. Again there is knowledge of animal needs and how to meet them implied, that is extended in space and time.

Some cycads still survive in tropical regions. The cycads produce swimming sperm, requiring a moist surface on the female cone to fertilize the egg cell. The gingko also produces swimming sperm released from pollen borne on the wind to the female sporangia. These female organs are naked at the tips of special shoots and not protected by cones. These ancient forms were outpaced by the conifers that still survive in great abundance today.

The conifers are much more elaborate in their organization. Many produce spreading crowns supported by huge trunks over 50 feet thick reaching heights of 300 feet, such as the giant redwoods that span a few thousand years in their life cycles. Evergreen needles provide most conifers with a distinct advantage in the short growing season at higher latitudes. Different root systems have been explored for varying conditions of moisture, frost, and need for support. The conifers have various other refinements of structure including a resin filled system of ducts in their stems and leaves to inhibit attack from microbes and insects. The resin produces spruce gum, amber and the familiar aroma of pine forests.

All these developments of *form* incorporate *knowledge* of many very diverse factors that go beyond the prioritized commitment of resources to *routines* in the host plant. Not only do they incorporate *knowledge* of biochemical properties but also a knowledge of complex environmental processes extended in space and time, from preventing the dehydration of eggs and sperm, to the flight characteristics of seeds, the feeding habits of animals, birds, and insects, and the climate of the new terrain to be colonized. These diverse factors must be brought together and integrated coherently into the facilities and infrastructure of the whole plant.

To an impartial observer it should be unnecessary to numerate the number of false sets of trials by accidental mutations in concert that would be required before successful combinations of so many factors converged without benefit of intelligent feedback and input. This is especially so when the result is consistent with such an obvious self-similar pattern that clearly implies intelligence at work in the evolutionary order. The complete plant implicitly reflects the *knowledge* inherent in its living *form*. Its various organs must relate to one another coherently and appropriately. The integration of space and time thus takes another major step forward at this *form-knowledge* level.

Form-idea:

The *idea* level of the plant kingdom is not an isolated venture. As plants evolved at this level they also provided nutrients for species of animals higher up the ladder of sentience. Without this food the animals could not have evolved in tandem. Even the insects couldn't have diversified. The higher sentient levels, especially the higher mammals and birds, needed more concentrated food provided by flowering plants.

The seas were already teaming with many species of invertebrate and vertebrate animals in the Carboniferous period, some three hundred million years ago. Carboniferous bogs were crawling with amphibians and giant cockroaches, with giant insects droning overhead. It was only at the end of the Cretaceous, with dinosaurs at their zenith, that the flowering plants, called angiosperms, began to diversify. A few species of magnolia and water lily had been around much longer, having diverged typically early in the previous level, but widespread diversification waited for the demise of the dinosaurs. It is as if the flowers came for the funeral.

In the angiosperms the pollen grain germinates on the flower's stigma, producing a pollen tube that grows down through it to the ovary, where the female gametophyte is housed. The male gamete then flows down the tube and fuses with the egg. As the seed matures, the carpel that surrounds it grows into a fruit. Flowers are thus adapted to attract an insect pollinating vector, and their fruits are often designed for dispersal by animals by providing them food not essential to the seed.

These plants also refined their vascular systems with more efficient water conducting vessels, and their foliage, stems and roots usually have concentrated nutritional value. The flowering plants thus exploit new *ideas* that integrate processes extended in space and time that are of critical value far beyond their own survival concerns. The angiosperms are essential to the progression of the whole evolutionary process, and they constitute two thirds of all living land plant species today. Virtually all land mammals and birds are dependent on the more concentrated food supplies offered by flowering plants to support their higher metabolic rates.

The earliest angiosperms were probably woody shrubs. Although there has been some disagreement on whether the first angiosperms evolved from gymnosperms or seed ferns, they typically evolved from an early variety of seed plant, not from a highly evolved gymnosperm at the top of the *form-knowledge* level. So all that digitized information encoded in DNA would again be lost to them if the Darwinian theory is right.

There is evidence that the magnolia is ancient and that the first flowers were probably upright cone-like structures with flower parts derived from leaves arranged in a spiral sequence. The uppermost leaves harbored female ovules, which they enclosed to form the carpel. The next set of leaves became modified into male stamens surrounding the carpel. Next came the petals which became modified in color, many developing sugar secreting nectaries to attract insects. Last came the green sepals that provide a protective covering for the bud and a base for the flower together with the receptacle. A great variety of floral types have evolved from this basic format.

The carpel typically consists of a sticky stigma that receives the pollen, connected by a stalk (style) to the ovary that contains one or more ovules. In insect pollinated flowers the stigma is contained within a colorful flower, while in wind pollinated flowers, such as in grass and silver birch, they are exposed, with the petals and sepals reduced or absent. A few flowers fertilize themselves. Upon fertilization the ovules develop into seeds and the ovary wall develops into a fruit containing the seed(s). The enclosing fruit distinguishes angiosperm seeds from naked gymnosperm seeds.

Fruits fall into two general types, dry or succulent. Dry fruits are dispersed by mechanical means. The dandelion and thistle have a parachute to carry them on the wind, the sycamore and maple have wings attached, burrs hitch a ride on animals, peas and beans disperse from a pod.

Plums, mangoes, acorns, citrus fruits, almonds, coconuts, etc., are succulent fruits. They may contain one seed as in a cherry or many as in a berry. The fleshy succulent part of a fruit may also develop from the receptacle as in a strawberry and apple. Sometimes seedless fruit can form without prior pollination of the flower, as in bananas and pineapples.

Fruits come in large variety and are often dependent on animal dispersal. Some violet fruits are carried by ants back to their burrows, where just a small droplet of oil produced by the seed for the purpose is consumed by the ants, thus planting the seed intact. A clever idea, employing a *knowledge* of preferences in the ant’s diet and also of the complex biochemistry to produce it.

The succulent fruits are not essential to the germination of the seeds they contain. And they are produced in such abundance with such a generous allotment of fleshy food stores, that it is hard to believe that they evolved solely by accident and selection pressure with such a large amount of wastage for self-serving seed dispersal. There is also a considerable variety of food storage in root systems such as the potato, turnip, beet, carrot, onion, peanut, yam, tapioca and so on. This allows some of them to reproduce vegetatively as well as by seed, in the process also providing abundant stores of food for animals.

Many flowers have developed fused floral parts, for instance tubular sheaths around nectar bearing organs that target only certain pollinators, such as humming birds with long curved beaks, and exclude others. Honeysuckle and sweet tobacco flowers are adapted to the long proboscis of a pollinating moth, but excludes bees and flies. It’s hard to see any advantage to the plant here. The fig is completely dependent on a certain wasp for pollination, and in winter produces sterile fruit solely to ensure the survival of its wasp pollen vector. Coryanthes orchids have a reservoir of fluid in the bottom of a deep chamber in the bloom that drugs bees, making them groggy so they fall in. There is only one possible exit from the chamber at the fluid level, directly beneath the stigma and stamens. On its first encounter two pollen sacs are glued to the bee’s back as it crawls out through this single long passageway to a higher exit, giving it time to regain its senses. On the next encounter another orchid’s stigma picks up the pollen from the bee. This is an extraordinary idea that could hardly have evolved by chance. Of the millions of organic compounds possible, the flower must hit on a drug that is strong enough but not too strong, and yet not discourage the bee from trying again. Its fluid consistency must allow the bee to swim for the exit, the dimensions of which must be precisely positioned with respect to stamens and stigma. Many factors must be just right and evolve in concert to produce the result. Otherwise there is no selection pressure.

As soon as a pollen grain attaches to the stigma of the carpel during the pollination of a flower, it begins to grow a male gametophyte pollen tube down through the stigma and the style into the ovary at the base of the carpel. It grows very quickly, an inch an hour or more. Once the pollen tube locates a female gametophyte embryo sac, not one but two male gametes flow down the tube. One fuses with the egg cell to begin producing the new embryo plant. The other fuses with two more haploid nuclei in the embryo sac, to begin producing the endosperm, a rich food reserve in endospermic seeds such as the cereal grains. In non-endospermic seeds the food is absorbed by the embryo, especially the seed leaves, called cotyldons, which are likewise designed to give a germinating seed a head start once it is dispersed. This provision of food stores for the germinating seed is a main feature of angiosperms, anticipating future needs and thus spanning space and time.

Angiosperms have a more highly differentiated vascular system than gymnosperms. They have continuous water conducting vessels formed of dead cells connected end to end by perforated plates to make a continuous duct, allowing for freer more organized flow. Growth processes and vascular bundles consisting of xylem and phloem tissues are more intricately arranged. Xylem vessels transport water and nutrients from the soil. Phloem vessels transport food from production sites in leaves to growing points where they are needed.

Many angiosperm leaves have elaborate protective measures, as in poison ivy, nettles and thistles. Some plant leaves and branches are sensitive with motor responses and fold up when touched. Some leaves are thick and succulent for storage of food and moisture. The leaves of carnivorous plants trap and digest insects. Again these ideas exploit *knowledge* of complex processes extended in space and time.

The angiosperms have greater differentiation of organs and organ parts than do the gymnosperms, and they have developed into a much greater diversity of different plant forms, spanning space and time on a broader scale. These *forms* have implicitly re-assimilated the *routines* and *knowledge* explored by earlier plant species according to a host of new *ideas* that are extended in space and time, far beyond the plants themselves and even beyond their own survival needs.

These developments came at a time when the continents were coming under compression forcing up new mountain ranges and plateaus throughout the planet. The dinosaur habitat rose and dried out, preparing the way for the next phase of vertebrate evolution in the mammals and birds, with major repercussions throughout the evolutionary hierarchy as it moved inexorably toward a new balance. The arrival of the flowers, together with the diversification of pollinating insects, signaled the departure of the dinosaurs, and heralded the coming of more refined and sentient creatures.

***

Commentary:

From the above we can begin to see that there is a progression through the evolution of the plants that parallels higher levels in the animals and complements their needs on ascending levels in the sentient hierarchy, especially on land.

The levels, described as successive levels of delegation apparent from the historical record, do not mean that flowers give explicit direction to conifers, which give direction to horsetails, which give direction to algae, any more than we should think that the president of General Motors gives direction to a local restaurant.

Each species has a distinctive number of levels delegated within its own biological organization. We may think of it as a single-celled algae functioning like a one man company, whereas an apple tree or a rose functions like a larger more sophisticated four level company. Within an apple tree the *idea* level integrates extended processes in space and time, from weather, to pollinating insects, to providing animal food. The integrating *idea* of the apple tree directs the accumulated *knowledge* essential to the development of its organs, which in turn directs its *routines* such as circulation through its vascular system, which in turn directs the *formation* of its cells in new growth consistent with available resources and needs. The direction is implicit in the plant's organization.

There is also a larger sense in which the higher species do give direction to the lower species, with feedback in the opposite direction, just as General Motors has needs in order to make cars that are provided for by a host of interdependent industries. Likewise every species is concerned with energy transformations up and down the evolutionary hierarchy, forever seeking a balance, so that major evolutionary developments at the top affect the whole hierarchy. The biosphere seeks dynamic balance within itself through biospheric resonance. The biosphere is in communication with itself and it seeks harmony. It is a resonating whole in which all life is interdependent. The whole hierarchy is humming in accord between levels, allowing members in each level to profit from the lessons of members on different levels. Otherwise the digitized information of DNA could only be progressively lost. Progress could not be recognized in the evolutionary process.

References

1. Robert Campbell, Downsizing Darwin: An Intelligent Face for Evolution. MindReach Library (1996).

2. http://cosmic-mindreach.com

3 Robert Campbell, Fisherman's Guide: A Systems Approach to Creativity & Organization. Boston: Shambhala, 1985