The Word and the Process

Science and Philosophy in an Evolving Biosphere

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There is a stubborn integrity of science (can we even call it an ethic?) that will accept Mistress Quickly's words of comfort to the dying Falstaff not to be thinking of God - "there was no need to be troubling himself with any such thoughts yet". It is such advice that has too often brought a battle between evolutionists and theologians - in fact needless, but still flaring up, or kept at bay only by what John Habgood (biologist & archbishop) called "the uneasy truce".

Someone recently remarked that the trouble with the "creationists" is that they just don't get the point - they can't distinguish between the necessary methodological materialism of science and a philosophical materialism.

The things we know best about Biology are the furthest removed from the highly abstract laws of physics and chemistry. It is from our own data of experience that we can learn something about other organisms like ourselves. Words like **adaptation**, **regulation** and **co-ordination** derive their meaning from our experience as personal beings. We know of the aliveness of life, not out of empiric observation, not even by induction, but in a way we could justly call 'shared feeling'. The proper word could even be 'sympathy'.

The complexities of a living world, while they harness physical laws, are not reducible to them. Each higher level has its proper rationale. Nor do we even find a graded transition from one level to a new one. When things get complicated enough they are seen to take on a life of their own.

The philosopher of biology Michael Polanyi found it "almost empty of meaning" for physical matter to be the ground of life and purpose. Uni-

versal knowledge of all things reduced to the laws of physics would tell us hardly anything interesting about the world.

The hierarchy of causation thus becomes less and less specific - and hence less informative. It is true that biology can be worked from either end - by analysis or synthesis. Indeed a fundamental division of human temperament & thought runs through biology itself. But biology's special responsibilty is not to pursue reduction down to atomicity. Its prime interest is productive and progressive: entrained on the building-up by life of novel and more complex systems.

A Paradigm In Trouble

Richard Strohman, *Nat. Biotech. 15* 194-200 (1997), has predicted what has been called a Kuhnian Revolution in the philosophy of science. A reigning paradigm (or explanatory model) sooner or later can develop anomalies. It produces errors until it falls under its own weight, to be displaced by a successor waiting ready in the wings. It is the paradigm of the GENOME that Strohman finds in trouble today. He finds its failure in the mistaken idea that complex form and function and behaviour may be traced solely to genes and their product proteins.

I can remember so well seeing - as a student - the brief letters in *Nature* in l953, where Francis Crick & James Watson announced a double-helix structure for 2-strand DNA. Such was its clarity and seeming explanatory power that the genetic alphabet was early brought into Stage I courses. Given such a coding the whole history of life - many were quick to accept - had been stored and transmitted. Molecular determinism was soon to be raised into the central pillar of biological science.

This high assumption is being increasingly questioned today. Richard Strohman saw the theory of the gene as

> "beautiful and magnificent in its utter simplicity. A child could understand it, and millions of children now do. But if you mistakenly ask them what it means in terms of function you have shamed them."

In fact - he claims - it has explained two things:

> "TRANSCRIPTION where DNA sequences become protein forerunners in the form of messenger RNA ; and TRANSLATION,

where the linear sequenced messages in RNA are converted to linear sequences of amino-acids in proteins . . . . End of story."

Yet, from fifty years of popular currency, genetic determinism still has great persuasive power. The gene industry is now a hugely-resourced world-wide trade commanding the major share of our research funding in the life sciences.

Teleology, with the intuition of **final causes**, has been deprived of all explanatory power. The whole theorem of Darwinism is to be retold digitally from the blind struggle for survival. The bodies of organisms, including our own, are in their intricacy and beauty of adaptation the throw-away containers of the "Selfish Genes". We cannot expect to understand why, for there exist no ulterior explanations; Richard Dawkins assures us "DNA just is . . . and we dance to its music".

The critics of this view would hold that the highest claim tenable for the genes is to see them as *instrumental*. They do not carry form or give instructions. Rather do they offer ingredients. They would thus operate at the lowest rank of causation - as material causes.

The first disability of the genes as an instruction-code must be their identity in almost every cell of the organism. There is no selective allocation. Every cell gets everything. It is as if there was a bare ceiling with all the pigments available at every point. To paint the pictures in the Sistine Chapel would involve information from somewhere else. So recourse was suggested to a second order of *control* genes, supposed to manage the structural or primary genes by specifying their dosage over a complex of space/time gradients. But such master genes would still in turn be part of a uniform genome - and powerless to differentiate a particular form.

So the next higher level has been in its turn invoked, called *epigenetic*. It would involve a whole complex of interactions, with open networking of l00 or more genes (by analogy with neurones), proteins and environmental signals. Far beyond the genome we have reached the largeness of the organism itself.

There are still some physiological cases where a unit gene might be said to equate to a finished character. These monogenic conditions are the main subject of current genetic "engineering". Such are the genes not of

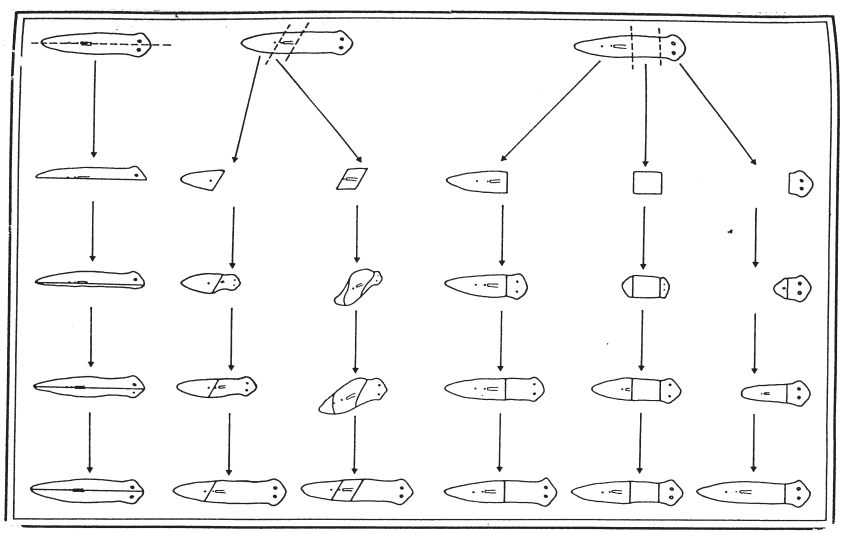
constitution but of condition. They may control size or colour or provide or suppress some critical enzyme. Thus in monogenic diseases such as haemophilia or muscular dystrophy or cystic fibrosis a single allele is crucial.

"The Presence of The Past"

Here then is the outstanding fact of biology, the high fidelity to the past that every organism shows when it replicates itself in reproduction, or makes repairs by regeneration, or merely maintains its being in homoeostasis. It is the real source of such species-memory as we must now go on to pursue.

A Field Effect?

We are are thus brought from the genome, through its epigenetic environment, to the involvement of the whole organism. In a classic experiment in the l870's, Driesch cut in half a sea urchin embryo at the 2-celled stage. Each resultant cell was found to produce not a half-larva but a whole one.



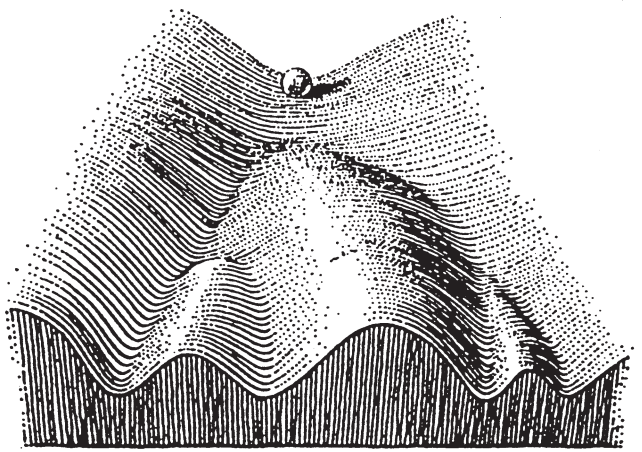
REGENERATION OF A PLANARIAN FLATWORM

Whatever the regulative principle, such a word as **vitalism** comes to be provisionally applied, without further spatial analysis, to the production of a whole morphic pattern. Similarly, after macerating a small vase-shaped sponge, we can find the fragment cells restoring their arrangement in orderly tissue layers, just as in a butterfly the complete breakdown of

the larva to a cell-soup is followed by faithful reconstitution - organ by organ - in the pupa. Or we may slice up the flatworm *Planaria* in whatever direction, and find each piece regenerating to a complete worm.

An Epigenetic Landscape

In the l940's embryology was dominated for us as students by the powerful book of Richard Paul Weiss, 'The Principles of Development'. We had been led to the supposition of fields by which regeneration or normal development is marked out. Carl Waddington called these fields 'epigenetic landscapes', and one of his early books had an aerial photograph of a vast railway marshalling yard, with repeated branching & subdivision out to the ultimate sidings. Thus, by ever-narrowing and more specific individuation, each separate structure or organ took its proper line, to its final site & form. Waddington's finished landscape consisted of channels or **chreodes**, down which an organ primordium could roll to its destiny. But all this was accepted as no more than a descriptive model of what in fact happens. Developmental fields had no explanatory or causative role.



Faith in Chemistry?

Patterns within the field were in the l930s increasingly supposed to be evoked by a chemical organiser. Thought to be a complex steroid (in the frog or newt located in the dorsal lip of the blastopore), this substance was seen as a "first mover" in releasing wholly unexplained differentiation effects. A foreign dorsal lip, transferred to another part of the germ, could moreover induce a second embryo. But there was no success in identifying the supposed organiser substance. Other stimulants

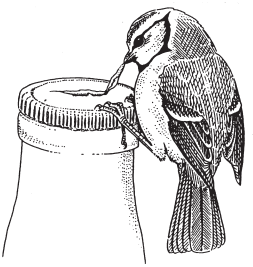
such as methylene blue (even - it was irreverently suggested - cheese or a bit of bus ticket) could produce similar effects. Chaos enveloped the notion that chemicals can somehow produce things.
A generation later - in the '60s - it was not only things but even "thoughts". A systemic mutation of the RNA in the wrappings of the neurones was held to write-in each novel item of experience, thereafter to be held available for read-out as conscious or subconscious memory. Ambitious projects were set up, such as for feeding naive flatworms with RNA from instructed individuals. This could have been like teaching theology by putting the missionary in the cooking pot. Better indeed, it had been satirised 200 years before its day by Swift, in Gulliver's visit to the scientific academy at Lagado.

FROM "GULLIVER'S TRAVELS"

I was at the mathematical school, where the master taught his pupils after a method scarce imaginable to us in Europe. The proposition and demonstration were fairly written on a thin wafer, with ink composed of a cephalic tincture. This the student was to swallow upon a fasting stomach, and for three days following eat nothing but bread and water. As the wafer digested, the tincture mounted to his brain, bearing the proposition along with it. But the success had not hitherto been great, partly because the pupils had not yet been persuaded to go so long without proper food.

Morphic Resonance
Into this still mysterious scene was to come RUPERT SHELDRAKE of

Cambridge, with the most revolutionary and - I believe - liberating proposal in biology since Darwin. In 'A New Science of Life' (l98l) Sheldrake ascribed the role of instruction to resonant **morphic fields**. These are held to be objectively real, and to have a commanding role of formative causation in laying down the course of development. Though causative, such fields are not however like Plato's ideal forms eternal and invariant. For every species they are constantly subject to change, by picking up their complex resonance patterns sent back to them by the myriad oscillations of all the currently living individuals.

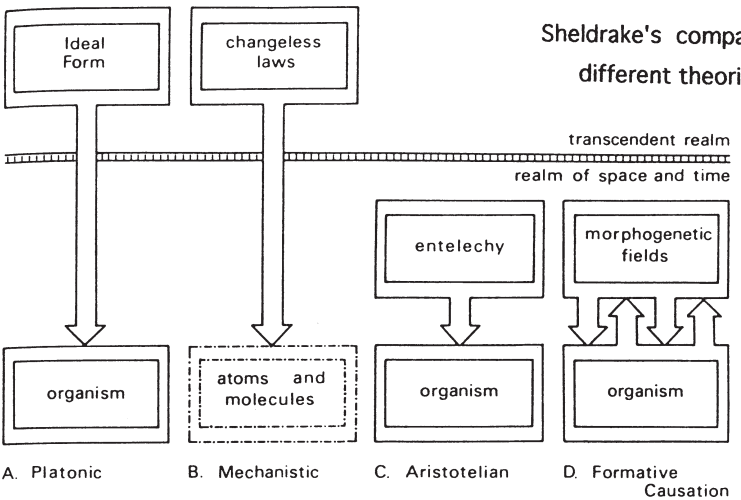


THE BLUE TIT

A now famous example, with its rapid spread *attributable to morphic resonance is the novel milk-bottle behaviour acquired by the blue tit. These birds learned to piece the metal-foil tops of bottles to reach layer of cream...First noticed in Britain at Southampton in l92l the habit spread to Scandinavia and the Netherlands in the 30's, even though individual birds never move more than a few miles from their breeding place. Milk bottles disappeared in the Netherlands with the war in l940, being restored only in l947-8. Though no pre-war birds could have survived, yet the habit reappeared at once, and in several widely distant places, with numerous individuals involved from the outset. It was soon widespread.*

So **morphic resonance** is claimed to involve a non-energetic transfer of information on the basis of rhythmic patterns of activity. All organisms manifest such rhythms, from the activity of electrons, atoms and molecules, to the rhythms of heartbeat, muscles and nerve cells. For each of these levels, the fields are nested in others of wider import.

Action is thus two-way. The field is itself set up by the resonance received and the species is kept in being (instructed and informed) by what is sent back. In its patterned complexity the morphic field is not individually deterministic, but is probabilistic, something like a mass identikit picture. In its quantum uncertainty it thus allows a significant measure of freedom in the organism's response.



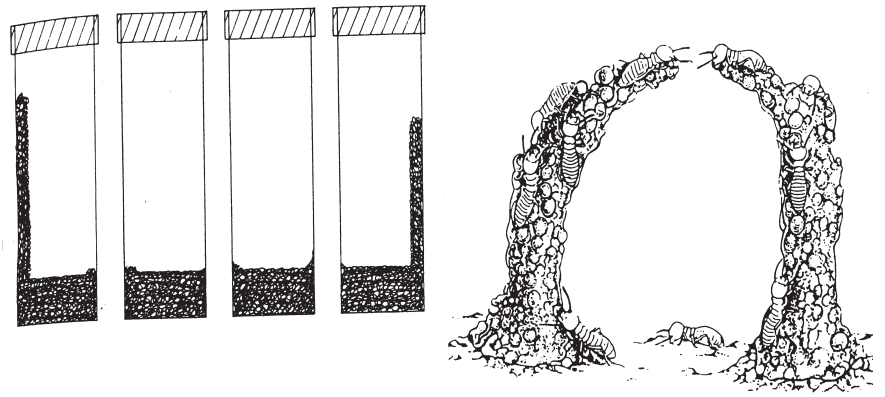
SHELDRAKE'S COMPARISON OF THE DIFFERENT THEORIES OF FORM
The Platonic theory has a one-way influence from the transcendent form to the organism. In the mechanistic theory there is a comparable one-way influence of the transcendent laws of nature on the atoms & molecules that make up the organism. In the Aristotelian theory however the organising entelechies are immanent within the organism and around it, rather than transcendent. In this way they resemble morphic fields.
However - maintains Sheldrake - entelechies like Platonic forms and transcendent laws, are fixed in nature and cannot evolve. They would not be affected by what actually happens in successive generations of organisms. By contrast, according to the hypothesis of formative causation, morphogenic fields are affected by what happens within organisms, and contain an inherent memory. They are evolutionary in nature.

Morphic resonance is held to occur between rhythmic activities on the basis of similarity. Past activity can thus continue, without any necessary decrement through distance or time, to influence the present. The sector being influenced is said to become buried within the species field. It is thus to be seen embedded in the chreodes or channels in the developmental landscape that lay out the course and flow of development.

Morphic fields are not then seen as metaphysical entities but as something empirically real, in the same sense as gravitational, electromagnetic, and nuclear-force quantum fields. What is new is that they are neither tightly determined by transcendent ideas nor describable by mathematical formulae. Though clustered with other fields of higher or lower degree, each species field is constituted under the influence of

all the individuals past & present. Through its available resonance, and being constantly subject to change, the field in turn sets the form of further generations.

If such fields were to operate in the mode of Platonic ideas or forms, they would in contrast have only a unidirectional causative influence. The actual forms of the existent organisms could exert no counter-influence upon the information systems. Platonic influences would remain changeless in their transcendence over physical reality. The invariant forms created by them would thus be permanently present everywhere.



Construction of vertical galleries by termites Heterotermes kept in plastic containers with building material. All chambers contained equal numbers of termites. Gallery building was suppressed on the walls adjacent to other containers. This influence passing from container to container was mediated by fields.
Three mimetic butterflies with "heliconiid" black, white and orange pattern. Genetic plagiarism in three separate families is suggested as deriving from the shared use of a morphic field.

Recognition & Tuning

Under the hypothesis of formative causation, organisms inherit not only their genes but their morphic resonance. Genes would have their essential role not in pattern forming, but in providing ingredients, as might tubes of artist's paints for a picture, or a load of bricks to be turned into a house. The genes' function is to produce the needed proteins, whether catalysts or structure-builders. They provide - as we have emphasised - the ingredients. But the determinative instructions are to be held the task of morphic resonance.

Sheldrake has memorably compared the genes to the electronic components of a television set. Neither contain form-information; both receive it from the world outside.

> "Changes such as a fault in a transistor can alter or abolish the pictures on the screen. But this does not prove that the pictures arise from the components, nor that they are programmed within the set. Likewise the fact that genetic mutations can affect the form and behaviour of organisms does not prove that form and behaviour are coded in genes or programmed genetically. Form and behaviour do not arise simply from mechanistic interactions within the organism, or between the organism and its circumstances; they also depend on the fields to which the organism is tuned."

How then does a developing germ become tuned to its instructing field or hitched to its star? Tuning must initially depend on the presence of appropriate genes and proteins that will recognise a salient part of the morphic field of their own species. A frog's egg thus tunes into frog rather than newt or goldfish or chicken fields because it is already a frog cell containing frog genes and proteins.

Chemical alterations in the genes could result in distortions to the normal process of development, just as interference with the components of a TV set can lead to aberrations of the picture. Some mutations could affect the normal development of the germ in quite small ways. Then there are those other gene changes (homoeotic mutations) that can entirely suppress an organ or a process, or even replace it with an alternative, as if the set were now picking up a different channel.

"Chance & Necessity"

These were the words of Jacques Monod's presentment of Neo-Darwinism with natural selection. Evolution happened with chance mutations of the genes which were held to be the sole source of heritable change. They appear entirely at random. Statistically they could be looked on as wanderings or "error". They bear no necessary rapport with the organism's needs. Most are indeed disadvantageous, some even lethal.

Such rationality as evolution may achieve is supposed then to have been

salvaged from the wells of Chance by the principle of Necessity. It is this that has been called Natural Selection, resulting in the so-called Survival of the Fittest, and held by the neo-Darwinists to be the sole motor of creative advance.

Yet there is the big difficulty that what would be the fittest for the future of the race need have little relation with what - in a present or short-term exigency - has been found to survive. No *a priori* criterion of fitness is available to determine the outcome. The "fittest" is thus no more than a tautology for that which in fact survives. The only Necessity is that "something" will.

We would so have a planless world - or a world in which mere survival is the surrogate for any plan. Survival of the fittest, with its fellow doctrine of Social Darwinism, is in turn the model for a *laissez faire* economy where we can never know what future we are making until that future has arrived.

Or if the future of things could be in some part predictable, this would only be because of the narrowing of the viable options in light of past happenings. Called *orthogenesis* , this would lead to safe-playing rather than creative advance. For Natural Selection can create nothing. Unlike gene mutation or crossing over, or even genetic drift, its only role can be to reduce variance.

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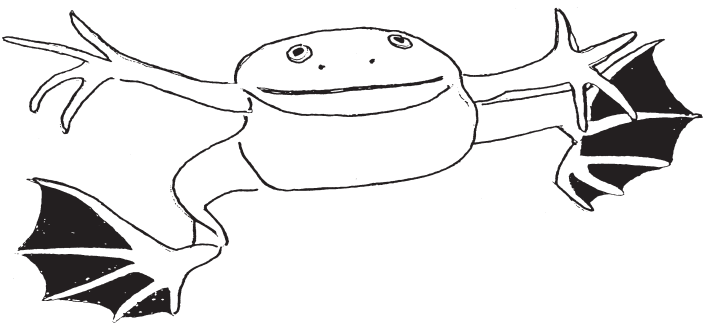
Behaviour Leads The Way

Instant structural change is hardly imaginable. The organism's first response must thus come through behaviour. The capacity for such response must greatly vary with species and circumstance. Yet behavioural flexibility must always be enough for the individual to be in a significant sense 'free', in whatever degree it may however fall short of conscious reflexion.

Behavioural change could in turn be expected to have early effects on structure. New bodily forms could be founded on changing habits. Evolution would thus come as *the origin of habits* , with behaviour primary, and all else following in its wake. To Darwin a structure meant a habit, and a habit implied not only an internal need but also outside forces to which the successful organism must accommodate.

For one example out of multitudes, we may look at the frog's foot. Though close to those four-legged amphibians that took the first steps on land, frogs and toads never seriously exploited the new-evolved foot for walking. Instead, the hind limbs became specialised for leaping, and in *Xenopus*, the horned toad of southern Africa, the legs were used for swimming. With wide splaying of the toes and repeated thrusts of the foot against water, folds of skin between the digits would have begun to enlarge and strengthen as webs. Nothing is at first hereditary: simply what has long been called an "acquired character". This is a modification derived from function. Sometimes a change of function can lead to reduction or loss of a structure; but our frog gives an example of "use-hypertrophy": an organ growing larger with intensified function.



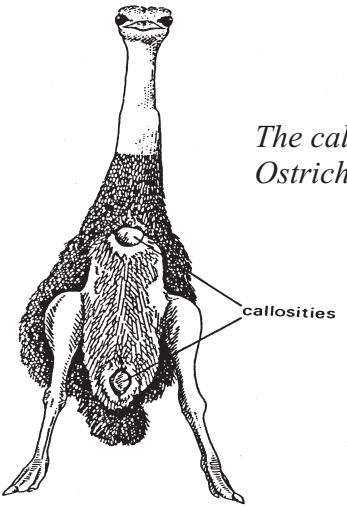
The frog/toad foot can provide a host of other structural adaptations, all evidently initiated in behaviour. Tree frogs (Hylidae) can climb, with the digits flexed for grasping. As well they can expand the tips of the toes to develop suction discs. There are even arboreal flying frogs, gliding between branches on broad webs of hand and foot.

Function Prescribing Form

Some of the best-documented translations of stress into structure can be seen in the realm of orthopaedics. The trabeculae of hard bones are related to directions of compression & tension in the same way as an engineer reinforces concrete girders. Structure is matched to the lines of force, according to the rules of bone growth operating in life.

Function can so be seen determining form - not just episodically, but regularly and meticulously throughout life. It points up a truism that every structure is not only inherited but must also be in every generation acquired.

Yet all the teaching we grew up with as students assured us that modifications arising from function could have no evolutionary relevance, because they were not represented in the hereditary genes. Thus - however difficult to believe - the inherited horny calluses developed on the chest and pelvis of the ostrich where it crouches on the sand happened to turn up independently of the fact that similar modifications can be induced by behaviour in life.



The callus pads of the Ostrich

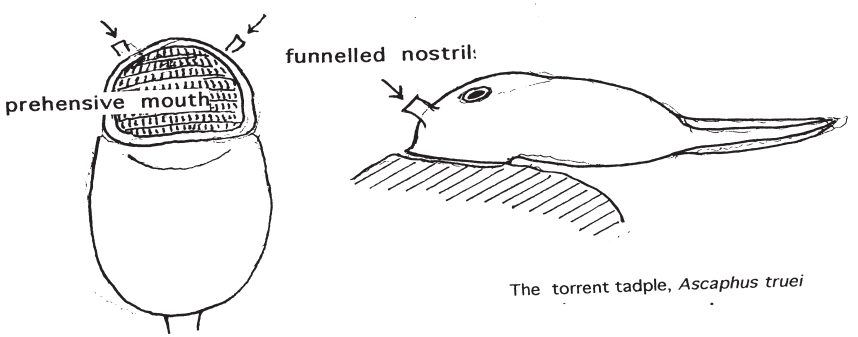
Could it not be possible that signally useful modifications initiated with behaviour could themselves take on enduring evolutionary significance? The Darwinist answer was firmly No. Yet it seemed to me that even under the current orthodoxy there had to be more to it than this. For a new behaviour already operative and producing a structural modification (SM), would clearly improve the likelihood of selection of any genetic variation (GV) that might turn up with parallel or similar effects. Likewise any engagement of behaviour would from its inception provide a climate of selection value (SV). Such a common-sense postulate - although I did not know it - had half a century before been proposed and given a name. It was the Baldwin Effect, alternatively called Organic Selection, that had - in the misleading climate of Weismann - remained buried in literature from the turn of the 20th century.

It becomes a question whether the gene mutations - so long held sacrosanct as in a line of apostolic succession - really by their nature stand so fundamentally apart. The development of the ostrich's callus, the frog's foot webs and the bone's trabeculae, whether initiated by genes or behaviour, evidently involve the same histogenic process at the same site.

Who is able to deny that they could be one and the same change, part of the organism's intrinsic proneness, though being delivered in different ways; and that if occasioned by modification, they can in the natural course - in Waddington's phrase - become genetically assimilated?

The Torrent Tadpole

Confident that something like this must be regularly happening, I used to invite my first students to consider another amphibian, the Canadian mountain frog *Ascaphus truei*. Its specialised tadpole lives in torrential streams, clinging to smooth stones by its much-widened mouth lined with file-like rows of teeth. Such attachment has very plausibly led to other structural changes. With the mouth pre-empted for a sucker, the nostrils have been converted into wide funnels to bring in food particles with the respiratory current. The body has at the same time become broad-based and streamlined to resist currents, while the dragging tail-fin is reduced.



The torrent tadple, *Ascaphus truei*

All these alterations - common sense would again suggest - could have been initiated and improved by constant behavioural use. While the need remained, the mouth could in each generation be expected to gape wider and cling tighter, with the nostrils further enlarging by water passage.

It was only in l965 that a zoologist of front rank, Sir Alister Hardy, came to recognise the Baldwin Effect with the weight it deserved. Natural selection was then seen to be operating in two ways:
(i) external (involving the physical and climatic environment, and the biotic effects of other animals and plants, as well as intraspecific competition with others of the same species); and
(ii) internal (involving the organism's inside milieu and - most importantly - the individual's own behaviour). For the internal effects Hardy revived the term *Organic Selection* , first used at the beginning of the century by Baldwin in America and Lloyd Morgan in England.

Hardy's considered insights into behaviour and organic selection were presented in his Gifford Lectures and his classic book 'The Living Stream' (l965).

Organic selection could clearly be the way the organism makes structural provision for an intrinsic thrust first manifested in its behaviour. Natural selection, though still - in the Darwinian mode - playing its important part, would now have to be seen as pruning or restraining a tree. The organism was itself responsible for its pattern and strategy. It could no longer be seen as just a matrix for the thrust or "insult" of an outside environment. Change must be at its own first initiative, through the resources of its morphotype and constitution. In the initiation of such change, the organism was to be held in a significant degree "free". Hardy thus summarised the careful reasoning presented in Morgan's 'Habit and Instinct':

> When organisms enter a new environment, those with somatic plasticity develop changes. Those without plasticity do not, and being unequal to the occasion are eliminated. This may happen generation after generation, with changes plastically acquired and not inherited. However, although there is no transmission of structural modifications (SM) to the germinal substance, congenital variations (CV) in the same direction would not be repressed but given full scope, tending to favour the individuals in which they occur. Any variations antagonistic to the modifications will tend to be thwarted, and render their possessors liable to elimination. Thus will arise a congenital disposition towards the modifications in question. The longer the process continues the more marked will be the predisposition and the greater the tendency of the congenital variations (CV) to conform in all respects with the structural modifications (SM). With plasticity continuing, the modifications will become still further adaptive, being genetically augmented while themselves giving compatible genes selective advantage.
>
> The process thus becomes circular, with plastic structural modification initiating and germinal variation following. The first paves the way for the second. Natural selection will foster variability in advantageous lines when this has been once initiated by behaviour with its induced modifications.

In the day-to-day working procedures of the geneticists - involving new

engineering of the genome - few operational changes might in fact be necessary from our new understanding of the genes as ingredients. There might however be evolutionary changes, such as the acquired behaviour of blue tits with cream bottles, that do not initially involve gene changes at all but could be transmitted to and from the morphic field.

A generation before Sheldrake, Alister Hardy had courageously suggested a role for telepathic communication. It could in fact be only through a shared field understood in Sheldrake terms that a species does not become a dispersion of monads but maintains its real ontologic unity. Each developing germ would align to this unity, hitching to its guiding star by picking up the cues from the strategic recognition of shared proteins or genes.

Co-creative and Free

Sheldrake's 'Rebirth of Nature' was to restore to us a reminder of the freedom natural historians have long intuited life to possess. The living world is seen as innovating and adapting in the constant pursuit of goals. This goal-directedness must flow from life's defining property of perception of stimuli: entailing communication and behaviour consciously adaptive to aims and anticipations, as expressed in the philosopher's careful, yet understandable word 'intentional'. But for the vast majority of creatures, such problem-solving will not translate into reflective self-consciousness; nor shall we forget what a great proportion of human behaviour remains below that level.

Ideational consciousness of the self seems a human acquisition under the governance of the (major) left cerebral hemisphere. Still governed by the (minor) right hemisphere are all the complexities and directedness of something like a sub-conscious mind. It is evidently in human life alone that some of these operations are projected into consciousness, with the two hemispheres cross-connected by the great commissure of the corpus callosum and the smaller anterior commissure. But non-human life may still in effect be enjoying, inchoatively and non-reflectively, something like the goal-directed freedom of our own actions, and even volitions.

Recognition that behaviour leads the way, with function in advance of structure, could offer some reparative justice to Lamarck. For we find these same needs and drives of the organism expressed in Lamarck's *besoin*, however clumsily the critics had rendered the word as 'desires'.

Like Lamarck, Henri Bergson in 'L'Evolution Creatrice' (l9l3) saw living things as innovative and free. Life was striving to find its outlet, pitted against an inanimate environment that is all the time being broken through. Indeed the world's primary division runs between life and matter, and life's main-spring is Bergson's *elan vital*. Life is seen as unified, continuous, and only to be fully manifest by its flow with time. Matter - to Bergson - was that into which the analytic intellect likes to carve up reality.

To Bergson, both Mechanism and Teleology imply that the future could conceivably be known in advance. Both would deny the possibility of real novelty. As distinct from either, Bergson saw life as essentially creative, like an artist's work. While the non-living world is driven by entropy under the second law of thermodynamics, life's special metier is the local reversal of entropy. Life is seen winding up in a total world that is slipping back: climbing towards ever more advanced levels of organisation; it may even be likened to sailors scaling up the rigging of a sinking ship.

The Mystery of the Given

With his theory of morphic fields, Rupert Sheldrake remained reticent about first origins. Yet he well recognised the central and ontological mystery: how any particular thing as unique and hence improbable as a frog or a foxglove should ever have happened. Thus, morphic fields that operate two-way - in novel uptake as well as continuing replication - pose new questions to which they must be looked to for answers. We ought not to be surprised or disconcerted if apprehension of morphic resonance, bringing us to fields of a quantum order, or even beyond, should prove unable to reach past apprehending to full comprehension in ourselves as creatures in its outcome.

Sheldrake's fields offer more than the descriptive epigenetic landscape of Waddington, or von Bertalanffy's promise of a General Systems Theory, or Brian Goodwin's supposition of mathematical laws of biological development that somehow replace traditional reliance on genes. These recourses are of no ultimate help, nor even of real interest. They are like calling up answers "from the vasty deep". The real doubt is whether they will do their work when called upon.
Just as unhelpful must be Prigogine's pictures of spiral waves appearing spontaneously by chemical action or stimulation with a hot needle.

Complexifying form changes were here suggested to be generated by naturalistic means as material effects. But as Sheldrake emphasises, the appearance of some random "doodle" gives no assurance of the emergence of any definable or particular structure.

In all this the fundamental error must be to imagine that particular forms can be answerable to general laws for their existence and unique character. Philosopher Gilbert Ryle (himself no friend of metaphysics) has given us stern warning that the laws of nature are not causes but only governing conditions:

> "Natural laws do not ordain everything that happens. Indeed they do not ordain anything that happens. Laws of nature are not fiats."

Particular forms are with us as part of the mysterious given. We sometimes use for them the term surds (with its connotation even of stupidity) to underline their ultimate irrationality. While the formula is rational, those peculiar constants stay mysterious. It is like having a valid syllogism, with the major premise demanding acceptance unexplained.

The Word and The Process

The argument pervading evolution is about God's original creativity against the creature's freedom of co-creativity, in response to its own nature and goals and under the pressure of environment. This battle has been left largely un-faced or avoided by scientists and metaphysicians in today's uneasy truce.

We need to look at two separate levels to which the evolutionist has given distinguishing names. The first to happen (though not the one we most familiarly see) would be the appearance with something like spontaneity of a novel morphotype or - as we'd now call it - a new morphic field. This - like a takeover bid - need not involve alterations of detail at the lower nested levels. It will be a matter of a new and over-arching pattern embracing and pressing into use older ones at the levels beneath. What is going to change is not the working conditions bench by bench but the higher policy and management levels. As Sheldrake writes,

> "new patterns include old ones within themselves. Nevertheless they are new and come into being suddenly. They have a

> wholeness and integrity that do not admit of gradual appearance. The fields are wholes and precisely because of their irreducible integrity they have to appear suddenly".

This is the kind of change that is called *anagenesis*, recognising it as the basis of periodic but continuing advance. Though it occurs everywhere, from plant life history to the separate phyla of animals, it may be exemplified most confidently in the progress within the "anthropic" vertebrates leading up from fishes to humans.

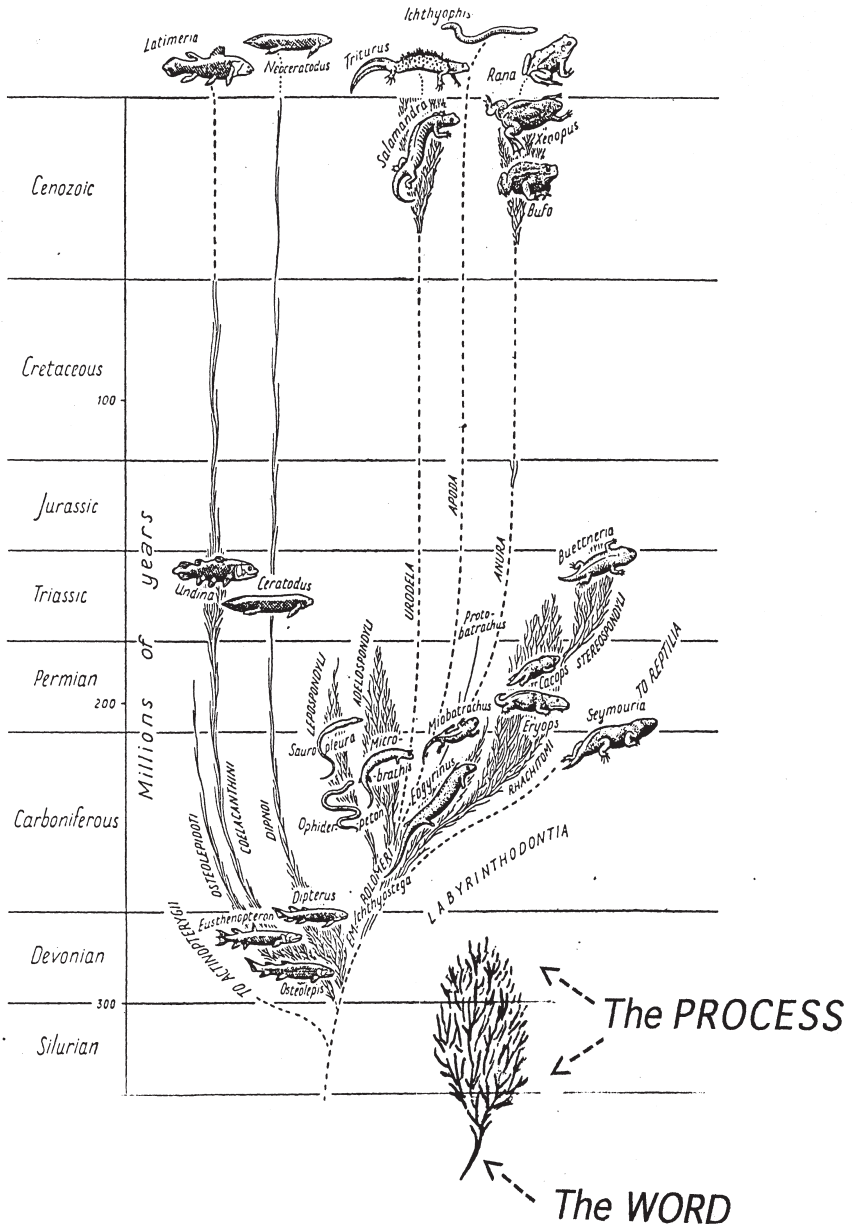
The second and smaller, but by far the more familiar and continuous, mode of evolution is what we call *cladogenesis*. It concerns not fundamental change but - as the name suggests - shorter and repetitive branching, in the nature of adaptation and radiation within the same morphotype. The old notion of a morphotype goes back to the beginning of the l9th c., before evolution was properly understood, to the botanist de Candolle's view of a basic plan underlying each natural group - "*suivi avec tenacité mais varié avec richesse*".

These two - in some ways contrasting - modes of evolution are well illustrated in a cross-section through the vertebrates, with cladogenesis involving an enriching diversity at the same level, but anagenesis striking towards higher levels. There is progress, as we may see, from fish to 'four legs', then through reptile and mammal up to primates culminating with humanoids.

Escape from Specialisation

A new morphotype is much less likely to originate from the farthest evolved reaches of any existing one. High specialisation will have gone deep, largely to preclude or cut off alternative options. New progress is kept open by avoiding an overspecialised commitment and holding to something of a generalised plasticity. This is true with the primates among mammals, the mammal precursors in the reptiles, and the first reptiles, with amnion and allantois, arising suddenly from amphibians far more basal than frogs and toads.

One repeated opening to progress has been what de Beer called neoteny or "escape from specialisation". Later appearing specialisations have been lopped off by more basic juvenile forms becoming precociously reproductive, as has been suggested for sea squirts (ascidians). It is a return to a base for a leap forward.



EVOLUTION OF THE "WORD" AND THE "PROCESS"
The phylogeny of lobe-finned fishes and Amphibia, showing successive chapters of anagenesis, with each developing the radiate fine branching of cladogenesis

Another happening well explicable from morphic fields could be what Sheldrake has called *evolutionary plagiarism*. One of the most notable examples is the intricate black, white and orange and red mimetic patterns developed in heliconiid butterflies, and imitated with precision, in all its complex detail, in two other families, not by coincidental many-stepped natural selection but far more plausibly, I would even say evidently, from the shared use of a morphic field. It could even be that the numerous parallel adaptations in marsupial and placental mammals have been derived by the shared use of morphic fields.

Melinæa imitata (Ithomiinæ) | Helinconius telchinia (Heliconiinæ) | Dismorphia praxinoe (Pieridæ)

A Creative Trinity

Theological models of the Trinity have centred upon its creative work, reaching to humanity and throughout pre-human evolution. John Macquarrie has notably turned from the philosophic revelation of the deity to the existentialism or the notion of Being put forward by Martin Heidegger. In a Christian understanding, we first find God the Father as the original source and potential of a new creative IDEA, not yet particular or incarnate in material substance. His existence (if it can even be called so, being indeed transcendent over all existence) is seen as Primordial Being that we could not know at all were it not pouring itself out in Expressive Being.

Here then appears the second Person, the creative LOGOS, or the WORD. By its productive activity we are brought into a world of finite beings known as particulars, with differentiated properties and structure disposed in space and time. Thus could appear the novel Idea to which we have likened a new morphotype. Both theologian and scientist may approve of the term LOGOS, as the instrument and reason of particular creation, seen as a Person of the transcendent God.
In relation to creation, the Idea could be likened to a new WORD, put into a computer by means of a portable disc. The Word is so introduced

with a new particularity that was not there - nor thought of - before. The SON or LOGOS is then the agent of the Father in new creation. By his eternal action, the Son expresses Being in "the beings" bringing out in us the awareness that we are free and self-determinative, just as the whole creation has been called co-creative - in Bergson's *"evolution creatrice"*.

As we see it, God as Holy Being gives itself and demands our allegiance precisely because it does not gather itself together as pure and immutable. The God-head goes out all the time into the open-ness of a world of beings, a world of change and multiplicity and possibility. So creation happens all the time, at risk with free beings as in mankind choosing for themselves, even if there is in the Process a constant sense in which they are rejecting their being - even becoming alienated from it.

It is in such a world of beings, with societies at present alienated and individuals themselves falling into civil war, that the third person of the Trinity - first with Primordial Being and then with Expressive Being - is now to be recognised as UNITIVE BEING. The creative role of such a Being is to build up separate beings into a higher and wider unity than if Expressive Being had never moved out of the Primordial.

There was first the transcendence of God in the new creation of the WORD. The Word is now - in its very purpose, aim and goal - amenable constantly to PROCESS. This is wide-reaching and packed with unfolding potential. It is a destiny self-elected but always within the nature and ultimate aim of the organism. In human life it is to be realised in service to that aim, processed in accord with the WORD. In humanity - and even for pre-human creation - there is liturgic recognition that such Service can be called perfect Freedom. PROCESS is possible, though never externally enforced, through a God that in the creatures - ourselves and the whole evolving world - can be seen as immanent.

Aristotle's Biology

Confronted with evolution by the PROCESS, co-creative and free, all the while within the organism's own resources and initiative, it is perhaps time to look back to Aristotle. This is far from a retreat to antiquity, but offers a withdrawal from the long shadow still cast by Descartes from the dawning age of science.
No-one has seen this better than Rupert Sheldrake:

> By the scientific revolution of the 17th century nature was denied the traditional attributes of life, the capacity for spontaneous movement and self-organisation. She lost her autonomy. The souls that animated physical bodies in accordance with their own internal ends were exorcised from the mechanistic world of physics. Matter was inanimate and passive, acted upon by eternal forces in accordance with the mathematical laws of motion.

Aristotle was not only the first but probably the most meritorious of biologists in history. In sheer personal range, with no access to books, museums or classification, and with only his young disciples for colleagues, his comprehensiveness was unmatched until the 19th c. Darwin freely yielded to Aristotle the laurel that might have been his own; and his contemporary heroes Linnaeus and Cuvier he held to be mere schoolboys alongside "old Aristotle".

In a way hardly admissible in today's scientific ascendency, Aristotle was a vitalist. He was looking to the intrinsic capacities of whole organisms. He saw the organism "ensouled" with its own psyche, which is the principle of its being. The translation of psyche as "soul" need itself carry no spiritual over-tone of the human rational soul - *nous*. It is the subject material of today's psychology. It is also - with a ring of modern information theory - Dante's *virtu informante*.

Entelechy

It must be psyche that imparts information to unorganised "brute" matter. Without it Matter can have only potential - scarcely as yet real existence. It is then with Soul's instruction that Matter is constituted as a Body; and it is in just such a sense that Soul is the essence of the organism's being. This is what Aristotle called the *entelechy*, as the internal design or purpose. It is to be seen as a principle not just of being but of becoming. Since it is still in the process of becoming, Entelechy could not be said yet to have full realisation. Here it was that Aristotle saw the activity or ongoing movement that characterises all life.

Such movement in life carries a clear - if not explicit - connotation of evolution. Aristotle was probably the first to recognise those graded morphological series that are the ground-stuff of natural classification. It is still a big question whether he saw these natural series genealogically - as we'd say - in time, or as a merely logical *scala* or staircase of self-realisation.

As to the idea of original creation, it is not clear that Aristotle ever speculated. The notion of creation *ex nihilo* - within time or along with time - would have been wholly strange to Greek science, in a world supposedly eternal and perhaps cyclic. Aristotle seems to have been economic too in his thinking about God. He was prepared to see a supreme being as lure and attractant, drawing all life towards him in emulation - almost we could say un-reflective love - of his perfect goodness and beauty. Yet it was hardly credible that the same God should in turn love his creatures (if creatures they were). It was far more likely he wasn't even conscious of them.

Plato and Aristotle walk together - from Raphael

Raphael's portrait of Aristotle and Plato together finely captures their difference of temperament. Plato with gaze aloft is pointing upwards to the transcendant Forms and to the One. Aristotle's contemplation is on the earth, with right hand outstretched and the fingers spread - in that tribute to diversity that is then and always the naturalist's true credential.

Some have found it ironic that a re-discovered Aristotle was to be adopted into Christian theology in the intellectually fertile 13th century. But it has been suggested that while Plato had quite a complete religion

most of it was (by a Christian evaluation) wrong; whereas Aristotle had no religion to speak of, and could therefore more easily be baptised into one. So it was through Aristotle's renovation by St. Thomas Aquinas, in an age when Christianity was after all looking to be rational, that Greek science & philosophy were to find their historic culmination. Aristotle's First Mover by which things have been primordially set in motion ("which men call God") could stand as the foundation of Cosmological Proof in St Thomas' "five ways".

"The Mind of The Maker"

The integration of evolutionary science with natural philosophy could thus bring more intimate understanding from both the theologian's and the naturalist's side. We have looked at John Macquarrie's treatment of a trinitarian deity through something akin to Heidegger's existentialism. But perhaps the first or simplest analogy of the creative work of the Trinity could be from 'The Mind of the Maker' by Dorothy L. Sayers (expositor of catholic theology as well as forensic mysteries). Her picture of God's creative activity is that of a Book being conceived, written and read.

First, the creative IDEA is seen as the image of the FATHER, passionless and timeless, with the book already beholden, needing only to be written. The image of the book becoming actualised is that of the WORD. Here the creative energy is begotten of the IDEA working in time and itself becoming particular, incarnate - that is to say, within the bonds of Matter. The energy in the Word or LOGOS can alone make the IDEA known to itself or others. Yet the creative act is essentially identical with the IDEA.

Finally comes the image of the HOLY SPIRIT. Here is the descriptive POWER of the Book, conceived and then written. It is the way what is written flows back to the writer from his own activity. It is also the way the activity is communicated to the book's readers and produces from them its response. It embodies the biology of co-creation, and the theology of unitive being. It brings together in what Hooker long ago called a "harmonious dissimilitude" a world in which the organism reacts with its own being and upon other beings, and shows itself as co-creative.

This puts together for us in the language of theology what natural science has pointed at without itself explaining. It is looking at the organism co-creating and driven through change by its ENTELECHY that Sheldrake

and his school have once more brought us to recognise. Here is moreover the same evolutionary drive with cladogenesis that follows upon anagenesis, so the whole can be expressed in the thrusting metaphor of PROCESS operating on WORD.

The early belief of the Jewish people, with its picture of a creation out of nothing, stood clearly apart from the other great religions. It moreover still had little of the interest in science that marked the Greeks, in the the philosophy of Plato or Aristotle. Yet it has been from Hebraism that Christianity received its unique understanding of a creation not cyclic, but historically progressing and advancing. Here then was a God-head not held remote or automatic, but personal and rational, conferring from the beginning a freedom upon its creation. To explain a creation by laws inflexible and permanent such as the ideal forms of Plato or the changeless laws of nature could amount to something like a science. It could be questioned whether the Platonist philosophic world needed a science at all. But in the degree to which biological science emerged from Aristotle, it was ultimately to be baptised into Christianity. The need for a science moreover was true of Christianity - in a way that could not be ultimately said of the Greeks. To a Platonist, the living world might be explained by laws strictly laid down, with no progressive morphogenic changes. All explanations would thus be theological, with a science strictly un-necessary.

It is in the Jewish and Christian belief that we find an explanation of creation that reflects and indeed calls for science. It is the observation made by science that reveals how creation has in fact used the freedom it was endowed with when the Word came to be realised and set down in time. The original creation at the beginning, out of nothing, is from a transcendant creator in the Logos. Yet it is the same creation that falls thereafter to be pursued by science, as a creation under an immanent God, pursuing the process of evolution in a way perceived as co-creative.

This is far from a closed system to be explained from an original deterministic pattern. Its Godhead now is immanent. In the creature's freedom we can properly see the Word followed in turn and in due course by continuing and variable Process. Freedom and open-ness appear in evolution as the ongoing operation of the created world: they are maximised indeed in human purposive and creative activity. It was the botanist de Candolle - at the very opening of the 19th c. - who saw in each morphotype a living plan *suivi avec tenacité* - but *varie avec*

richesse. In creativity we could so discern a primordial God, transcendent as in the provision of the Idea as the Word, and an immanent God, concerned with the Dance, the Process that is Unitive and yet within its proper bounds co-creative and free.

Science and metaphysics should never confuse their working methods. But if Biology and Christianity are ever in our own day to recognise their need of each other and travel forward together in a natural philosophy of the Word and the Process, their first appointment could be once more a discovery of the Entelechy, true though it be that it can never be finally understood, presenting a state of Becoming rather than Being.