

**Stanley N. Salthe**

Natural Systems, HCR 86 Box 228  
Laurel Bank Avenue, Deposit, NY 13754, USA

**SCIENCE AS THE BASIS FOR A NEW MYTHOLOGICAL UNDERSTANDING**

The word 'myth' has in many languages acquired the meaning of mistaken belief. Certainly when a natural scientist or philosopher of science uses the word, he or she is probably referring to a belief that should be expurgated, that is somehow dangerous – myths can prevent us from finding the 'truth'. Well, I think this is mistaken; it appears that we always need, and always do construct, some kind of mythological supports for our activities. Of course, I am using 'myth' in its ethnographic sense of stories that make life worth living, that give it meaning.

**1. THE MYTH OF BEING FREE FROM MYTHOLOGIES**

Consider my own field, evolutionary biology, as a source of myths. First, we believe (and this is a key word), (1) that history is a fact, (2) that there has been a past which affected what we are now, that, in fact, organic evolution has occurred, so that living systems were not always as they are now, and that we ourselves are descended from other organisms that lived in the past (figure 1).

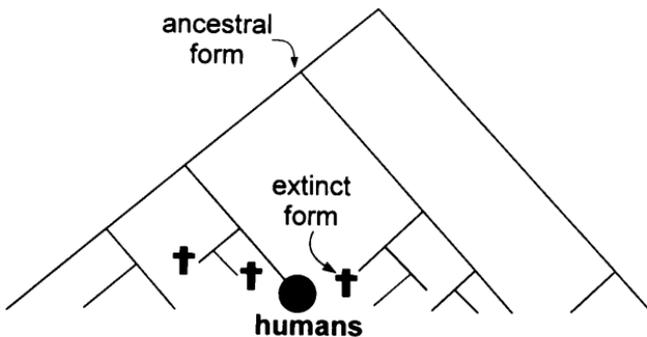


Fig. 1. The pattern of descent with modification, as in the current interpretation of organic evolution, showing humans as the end point of one lineage.

Furthermore, today we (meaning Darwinians) believe (3) that these transformations over time occurred by way of natural selection. This last belief entails the idea that different types of organisms are in competition with each other, and that those that became predominant in numbers (and so came to dominate their habitats) did so because they were better suited to prevailing conditions than were others, and so displaced them. This makes up a nexus of associated myths (figure 2) – beliefs that explain to us who we are, where we came from, and what our role in the world is to be.

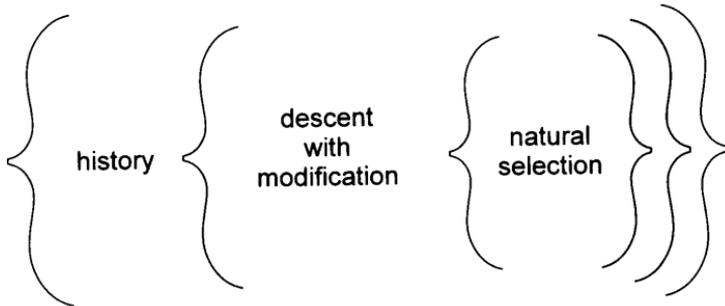


Fig. 2. The overall structure of current evolutionary "synthetic theory", showing its more general (to the left) and more specific (to the right) aspects.

Note that the form of this complex of beliefs is presented here as a set of nested classes. So, one can believe in history without subscribing to descent with modification (the pattern shown in figure 1), and, belief in the latter could be, but need not be, accompanied by belief that this descent is mediated through adaptation by way of natural selection. Commitment to the later, however, does entail the other, more general beliefs. The most general belief is shown to the left and the most specific one to the right. This form of nested classes (which could also be represented using the form of figure 1) is that of a *specification hierarchy*; crossing to the right into the next more highly specified subclass occurs in speculation when more statements are added, which increases the specificity of (in this case) beliefs. It is not necessary that beliefs be acquired historically in the sequence from general to specific; analysis of statements could also produce the pattern in figure 2.

The fact that it is possible to show evidences for these evolutionary beliefs in documents of the past, in fossils associated with ancient dates, and in experiments and observations on organisms in the laboratory and in the field, really only displays our particular criteria of credibility. Educated persons now use the criteria used in science – demonstration by detached observers of the

practical usefulness of general facts or principles. Other cultures might well have other criteria and they certainly did, and some perhaps still do. We now know that there can be no justification for any statement outside the confines of particular discourses or praxes (applied to science, we know this as the Duhem/Quine thesis – Harding 1976), and that these discourses in turn cannot be justified by anything beyond the brute fact of their successful continued existence. Furthermore, universal knowledge would be knowledge only of generalities (as in traditional basic physics and chemistry). As the work of Kurt Gödel (Davis 1965; Nagel & Newman 1958) and other mathematicians suggest, if this knowledge were in a logical framework (which science discourse is) and was not quite simple, it would have to (1) be incomplete (to save it from inconsistency), (2) be unable to be fully encoded, and (3) be indescribable in fully explicit detail.

Now, logical positivists and analytical philosophers have always cautioned us against belief. Not all positivists were skeptics in the strong sense – but unexamined beliefs were generally assumed to be in error. Myths are presumed, of course to be unexamined beliefs, in the sense of not having been subjected to critical scrutiny of their practical merits by detached observers. The facts that myths tend to be (1) functionally complete, (2) able to be fully dramatized, and (3) describable in as fine detail as anyone wants, all suggest that they are not, however, given their complexity, constructed solely using logic.

Interestingly, all of these characteristics of myth can be seen in Darwinian beliefs as well. Darwinians believe, for example, that natural selection can explain any fact of organic nature. Natural selection is a classical powerful idea; indeed, it has demonstrated a potentially global generality by leaping from one field of inquiry to another – from economics to biology to sociology to psychology back to economics to physics and to philosophy (as a form of evolutionary epistemology), and so on, with evidently no end in sight. And Darwinian adaptive stories can be written out in pretty fine detail as well (as for example, in the case of sickle cell anemia, which is a kind of ideal) – providing enough money and time may be spent on constructing them.

I would like to suggest that the positivist notion that myths are errors was an aspect of a *modernist myth of meaninglessness* – associated with what I call the Baconian / Cartesian / Newtonian / Darwinian / Comtean version of science (BCNDC science). The social role of this science, it now seems clear, was merely to be a tool for the prediction, control, and finally, the subjugation of nature. BCNDC science constructed nature (only by default, since it never wanted to produce a myth) as a place that could be understood sufficiently for instrumental uses by means of simple models (and theories). These models,

it must be emphasized again, were not constructed to serve as elements in a mythology. They were to be heuristic tools for overcoming the resistance of the world to our advances and claims of power. But note that, when we generalize, myths and theories (the linguistic bases of models) are formally the same kinds of thing. They are both explanations – theories, of a limited set of data (Campbell 1921); myths, of our place in the world. [It is interesting to note that when scientific theories become highly corroborated, they often become embodied in machinery (Galison 1987), and seem therefore to cease being myths, but this process is, I think, not very dissimilar to the creation of rituals that embody myths implicitly.]

The theory of natural selection, then, like any theory, has a general structure like that of a myth. But unlike most scientific theories, it also certainly does function for a great many people in "the West" as an explanation for why we are here and what we are doing here. According to it, we are here because our ancestors outcompeted the possible ancestors of then-potential (and now non-existent) others, and our role surely must be to outcompete other kinds as well – in particular other genotypes. But, since BCNDC thinking tends to generalize, we can be forgiven for supposing that this dictum extends to our associates, then on to other classes, then other races, and finally other species. Belief in the efficacy and hegemony of natural selection leads to belief in the necessity for competition. Whatever produced *us* must be real, necessary and good – is it not so? I would conclude that social Darwinism, for example, was not the brilliant construction of a few geniuses; it falls out of Darwinism quite ineluctably. This is shown by the fact that essentially these same conclusions have emerged from discourses influenced by Darwinism time and again. After the social Darwinians we had the German high command in the first world war, the likes of Sir Arthur Keith in the second, and now we have some of the sociobiologists (see, e.g. Alexander 1987). And before the social Darwinists we had the classical capitalist theorists in England.

The modern myth of meaninglessness, of which Darwinism is a key component, was perhaps best projected in Jacques Monod's book "Le hasard et la nécessité" (1970). In that work we find that we are the products of chance in our generation and of various determinisms in our continued existence. Our generation was a meaningless, a random occurrence; and our survival is closely determined by our surroundings. Chance suggests freedom, but the necessity of fitting into pre-existing structures (by a selection that weeds of those who do not) negates that possibility. A freedom hedged-in like this is empty, meaningless. From this, then there emerges no purpose, no project we could pursue that could make life worth living, or even allow it to make sense. (In Monod we find well expressed the tone of existentialism, which was an he-

roic attempt to survive imaginatively in spite of the modern myth of meaninglessness).

I would like to point out that the position of believing in no myth whatever entails some implicit, but important beliefs. Notably, positivists tend to believe, as I have just explained, in competitive individualism, but even more importantly, certainly in mechanistic materialism. These are substantial beliefs indeed, even though they seem only to be what is left when you have cleared out other, more explicit, beliefs.

Summing up my points so far: modern science was the tool of Western man's attempt to dominate nature. In order to facilitate this attempt, explicit myths (and religions) of all kinds were rejected as unnecessary and potentially obstructive. Belief was rejected, but could not be transcended. This meant that explicit older beliefs were replaced by others that either did not seem to be beliefs because they were taken to be self-evidently true (like belief that the world is merely a place of raw materials for our own use and a sink of our garbage), or that were held as beliefs unconsciously (like belief in the necessity for competition). Modern science itself, without intending to, generated many beliefs – gravitation, natural selection, entropy increase, and so on. And the combined effect of this collection of scientifically-based (that is, practically useful) beliefs in the intellectual climate of positivism was to construct our existence in a world of matter-in-motion as meaningless beyond the practical project of the domination of nature.

Our present dangerous relationships with the rest of the surface of the earth may well negate our own existence. Environmental problems would certainly be an appropriate result of praxes that were taken to be pointless and meaningless beyond the grasping for power. I believe we must transcend the thin anti-myth of meaninglessness if we are to come into less destabilizing relationships with our environments, which we now know (or ought to) that we cannot try to merely dominate without unforeseen costs, because the world is *complex*. It is no longer plausible that it is just a place, or a nonreactive source of resources.

## 2. A POTENTIAL NATURALISTIC MYTH

I believe we need a mythology wherein humans are constructed as part of nature, from which, for example, we were separated in the Semitic myth of the one god (which was and is being destroyed by Darwinism, which nevertheless has taken up its view of nature as a hostile wilderness). Our myth, like the anti-myth of meaninglessness, must be rooted in science if it is to have authenticity for us; its initial form must come from within science or it could not now develop as a credible discourse. Furthermore, it would have little credibil-

ity if it were merely a new construct jerry-built for the occasion out of bits and pieces of scientific lore. It must have the presence of an established viewpoint within science, preferably with a significant history. We must rediscover an established discourse as a result of the realization of our need for it.

Now, BCNDC science probably rose in part in contradiction to the very mythological source we are here seeking, which goes back to Aristotle – what I call *developmental science* (or just developmentalism). The thought patterns of developmentalism and of BCNDC science appear to have been counterpoised throughout Western thought, with one or the other being ascendant in any one period (Salthe 1991). Indeed, they both go back to Plato – developmentalism has its structural beginnings in the "Republic" (van der Meer 1989), while the strand leading to Darwinism and positivism can be found in the "Timaeus" (personal communication, Elmer Sprague). The works of Schelling and Goethe can be taken as previous examples of developmentalism, and Karl Ernst von Baer is a central figure (Salthe 1993). We have in this dialectical relationship between discourses to do once more with Barzun's (1943) distinction between classical and romantic, as well as with the analytical/synthetic distinction, and even perhaps with Nietzsche's distinction between the Apollonian and Dionesian.

**Thermodynamically open, autonomous systems (dissipative structures) show:**

- (1) After an initial increase, a monotonic average decrease in the intensity of energy flow (i.e., mass-specific energy flow) through them.
- (2) A continual, asymptotic increase in complicatedness (= size + number of types of components + organization, emphasizing different combinations of change in these at different stages of maturation).
- (3) An increase in internal stability (i.e., the rate of development slows down).
- (4) A decrease in stability perturbations.

Fig. 3. Four rules of thermodynamically-open, dissipative systems. From data in Trinchler 1965; Margalef 1968; Odum 1969; Zotin 1972; May 1973; Wesley 1974; Brooks & Wiley 1988.

Developmentalism has achieved a new vigor through recent interpretations of non-equilibrium thermodynamics coupled with information theory, and by developments in systems theory. Non-equilibrium thermodynamics, especially the branch initiated by Ilya Prigogine (e.g. 1955, 1980), has contributed the key notion of *dissipative structures* – dynamic systems that dissipate energy and information. Information theory has contributed a versatile concept of *dis-*

order (Shannon & Weaver 1949; Brillouin 1956) that allows a general formulation of development and ageing in dissipative structures (Brooks & Wiley 1988; Salthe 1989, 1993). Systems theory has been the locus of a recent re-emergence of scalar hierarchy theory (e.g. Miller 1978; Salthe 1985; Auger 1989), which allows a rich modeling of dissipative structures as parts of their environments. Importantly, we can now see that all dissipative structures exemplify *developmental trajectories* – larger scale entities encompassing all stages running from an immature condition through maturity to senescence and recycling (Salthe 1989).

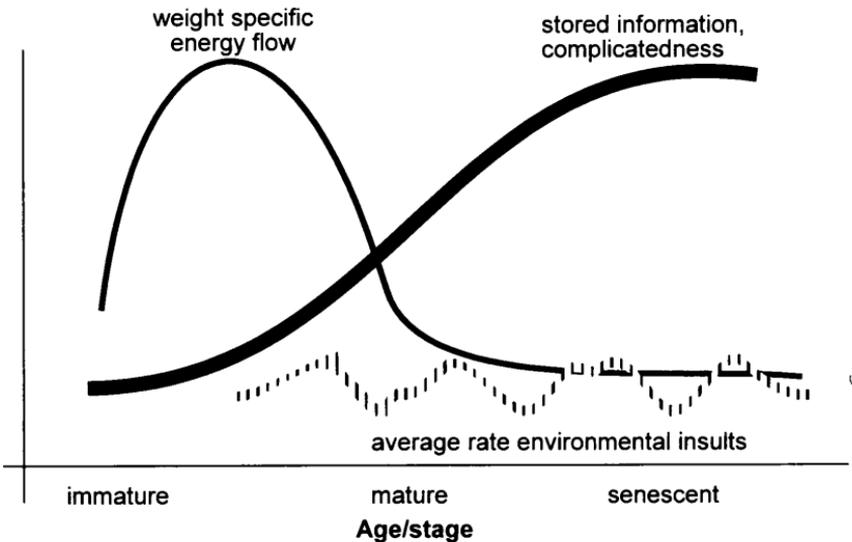


Fig. 4. General forms of changes in the intensity of energy flow and in the accumulation of stored information by dissipative systems. The energy flow intensity curve is overlaid by a typical profile of environmental fluctuations that could perturb the system, showing that in senescence a system increasingly fails to be able to marshal a requisite energy flow.

It appears to be the case that the ontogeny of organisms, ecosystem secondary succession and the history of the surface of the earth, at three different scalar levels, all demonstrate this same essential developmental pattern (Salthe 1989, 1990). Preliminary indications suggest that fluid vortices, like hurricanes, also undergo this development. Figure 3 shows four general developmental rules that appear to characterize change in all these systems. Figure 4 attempts to show them graphically. Immature systems are energetically hot, but relatively simple in form. They are developing at a fast rate. They

are quite flexible, and so fairly stable in the face of external perturbations. Mature systems are more complicated and powerful, being able to marshal relatively large absolute amounts of energy for various tasks, including repairs and the production of others. Senescent systems have simultaneously become energetically cool and complicated in form. This results in their becoming sluggish in their further development. Curiously, they become increasingly unpredictable in their behavior, because, lacking flexibility, they are no longer able to cope well with environmental fluctuations, which can easily perturb them – and so their material substance comes to be in danger of being recycled into other dissipative structures.

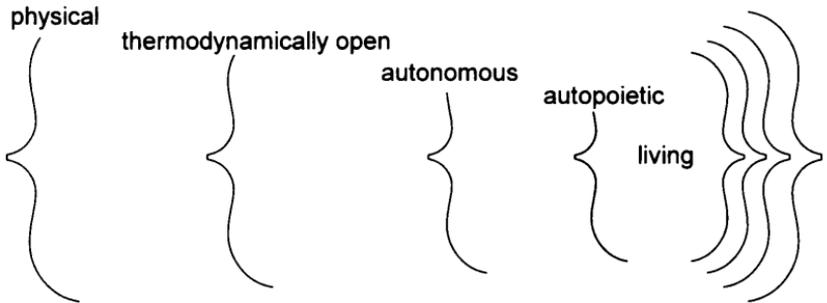


Fig. 5. Portion of a specification hierarchy of material systems. Any system may be examined from any of these viewpoints, although the diagram presents only those beginning from that of biological systems (in the innermost subclasses). These inner subclasses would have to be different for, say, a hurricane. Characteristics more generally occurring in nature would be found to the left, while increasingly specific, actual and particular aspects would be found toward the right.

These developmental relations appear to be the central image of a developmental myth, which I believe implies a kind of *neoanimism*. We are all, at every scale, undergoing these changes. This means that the earth itself, perhaps the entire universe, changes according to this pattern, previously acknowledged for organisms only; every dissipative structure seems to do so – every eddy in a river, every hurricane. With this realization we see that we are the same kind of thing as every other dynamic material system. Biological systems are only more complicated because of their relative stability, achieved through genetic information – we are especially stable dissipative structures.

If we, like everything else dynamic, are dissipative structures, then it would seem to make sense that all dissipative structures are individuals of essen-

tially the same kind as we are. Now, the realization that we are kinds of dissipative structures was made possible by generalizing to lower *integrative levels*, where dynamic systems all show similar structure (as in figures 3 and 4). Figure 5 is an interpretation of the structure of a hierarchy of integrative levels as a series of nested subclasses. Like figure 2 it is in the form of a specification hierarchy – so, all living systems are autopoietic, all autopoietic systems are autonomous, but only some autonomous systems are autopoietic, and only some of these living. Again, some of the living are social, some of the social are human, some of these are Caucasian, some of those males, one of these is myself, and one moment of my own trajectory is myself right now.

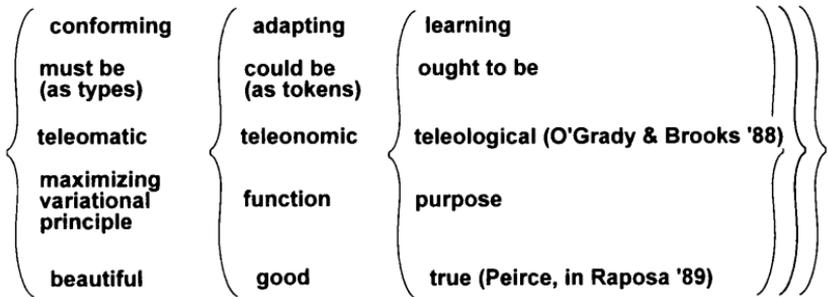


Fig. 6. Portion of a specification hierarchy showing predicates that relate to each other as being more generally applicable to most systems in the left column and predicates more specifically restricted to particular systems in the right. Each row shows predicates with "homologous" meanings.

In order to show the structure of this hierarchy further, examine figure 6, which shows a series of predicates, that, moving to the left in each row, become more and more general – that is, apply to more and more kinds of phenomena. These more general predicates are appropriate to objects in the sciences of vaguer integrative layers, those dealing with phenomena on the left in figure 5. Here, for example, in the second row, we see that whatever is must be as a type – given the laws of nature and of matter and historical constraints (initial and boundary conditions). But individual concrete particulars only 'could be', as tokens of those types. And, given our system of valuation, only some of these would be evaluated as 'ought to be'. Anything that ought to be could be as a token and must be as a type. (I include the last row in this figure only because it is intriguing given that it was suggested by someone of the conceptual acuity of Charles Peirce).

Now, for the purposes of this paper, I want to use this structure, which, as mentioned above, I refer to as a specification hierarchy (because, as you move to the right in this hierarchy you must add specification to your description), to argue that other dissipative structures must have the same properties as we have, but, as in figure 6, in a vaguer condition. Consider a predicate that we tend to associate exclusively with humans – say, 'intentionality'. Figure 7

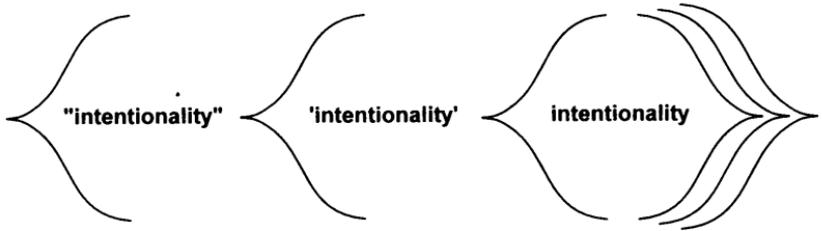


Fig. 7. Portion of a specification hierarchy of homologous predicates. Only intentionality on the right is an actual word. 'Intentionality' and "intentionality" represent concepts in need of new words to be applicable more generally in nature than is intentionality, which is restricted only to humans.

shows what I mean here. Using the specification hierarchy of integrative levels and the logic of classes, it is possible to argue that human intentionality must be a subclass of other, vaguer, phenomena at more general levels of integration. Of course, we do not have words for these phenomena – and, without words, they have little substance for us. What the specification hierarchy achieves is the realization that nothing we consider to be exclusively human can in fact be defended as such. Nothing comes from nothing. And the specification hierarchy implicitly supplies the words we need, even without their labels; it shows us where we need to invent new words. Hence, if we have intentionality, so do all other dissipative structures, but in many of them in very undeveloped form, for which words are yet lacking.

Furthermore, as we develop from embryos through fetal stages toward our own maturity, it must logically be the case that we gradually acquire intentionality in the sequence shown in figure 7. I can suggest this as a strong hypothesis (or potential myth) because we have already found that all dissipative structures share the same basic developmental pattern, as explained above (figures 3 and 4). Of most importance here is rule that we all acquire stored information as we develop (figure 4). I am suggesting, by using the specification hierarchy, that this information is laid in epigenetically, according to von Baer's law (figure 8). This sharing of the canonical developmental trajectory

(immaturity → maturity → senescence) by all dissipative structures represents the underpinnings of a neoanimism (which, incidentally, will allow us to understand why, for example, we bother to name hurricanes).

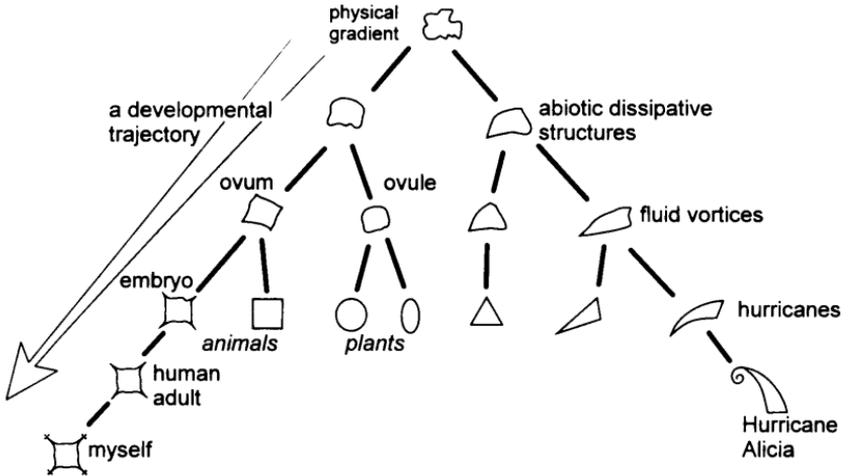


Fig. 8. Relationships between dissipative structures mapped onto their developmental trajectories. Development from one node to the next (irreversibly toward the bottom of diagram) is movement into a higher integrative level, and would be accompanied, if observed, by further descriptors in the observer's stored information. The diagram does not show evolutionary history (as does figure 1), but increasing individuation during development (ontogeny for organisms), hence, the nodes are developmental stages, not ancestral forms.

The developmental pattern of von Baer, as shown here extended to abiotic dissipative structures, can be viewed as a hypothesis of structural identity for dissipative structures – a shared transformation from comparative similarity to individual uniqueness. All dissipative structures appear to develop in this way from undifferentiated beginnings. This figure presents the main substance of the new, developmentally-based neoanimism. It needs to be contemplated carefully. Note that only entities on the left side actually pass internally-stored historical information to each other from top to bottom of the figure. The figure implicitly suggests that this genetic information is only involved in increasing the specificity achievable by living systems, but contributes nothing fundamental to the structures of change, which are universal in all dissipative structures. All of them become more highly specified with development, but biological systems can elaborate significantly more detailed forms, and so can individuate more intensively – a matter of degree, not of kind.

What figure 8 attempts to show is that all dissipative structures begin their carriers as physical gradients – living systems as gradients in germ cells. It suggests that there is no formal difference in these gradients despite their wide occurrence in many kinds of material systems. It posits, then, that Hurricane Alicia and myself were not structurally different at our inception. Each node in the figure represents a condition of not-being-different-from; so, e.g., at the ovum stage, one would not formally or structurally distinguish any of the animals. And it claims that at the appropriately vague integrative level the structure of the developmental trajectories of all dissipative structures are not different.

### 3. THE ROLE OF ENTROPY

The myth that emerges from developmental discourse today needs a source of activation – in fact, a *causa finalis*. This is supplied by recent interpretations of the second law of thermodynamics as a final cause. The so-called "heat death of the universe" can now be seen not to be in conflict with the development of complexity at all scales of nature. The argument here is in two parts. First, cosmologists like Steven Frautschi (1982, 1988) and David Layzer (1975, 1977) have shown us that the expansion of the world in the Big Bang version of cosmogony allows us to view increasing entropy and the development of increasingly complicated structures as being compatible. The general idea is that the expansion of the universe is too fast for matter to come to equilibrium distributions all at once. Instead, in its haphazard search for equilibrium, the dispersed matter in the universe continually collides, forming increasingly larger particles. Increasingly large clumps of matter form, then, as a result of the process of matter seeking equilibrium configurations randomly, colliding and creating friction, which slows down the movement toward equilibrium distributions even more.

Secondly, as suggested by Rod Swenson (1989), once matter exists in clumps, an efficient way to destroy these clumps as a movement toward thermodynamic equilibrium is found through the matter forming into systems that facilitate increased entropy production. That is, as the development of the universe continues, there should be an evolution of forms that increasingly channel larger and larger flows of energy into more and more entropic processes. Looking at organic evolution for examples, consider that a monkey produces more disorder and heat per unit time than does a frog, and that a frog produces more than, say, stromatolites or forms made of clay, suggesting that mammals emerged from primitive amniotes and animals from primitive eucariotes in part as solutions to the problem of maximizing entropy production on the surface of the earth. This view postulates that, given all the

material bodies produced in the Big Bang, thermodynamic equilibrium in the universe would be more rapidly approached through the agency of macroscopic structure.

Furthermore, generalizing from physical entropy to informational entropy in the manner made recently controversial by Dan Brooks and Ed Wiley (1988), we can see that macroscopic structure itself dissipates some of the energy flow used in its construction, and so its very existence is also an expression of a generalized entropy. That is, variety and diversity are taken to be forms of disorder. The more similar everything is, the more order (and predictability) there is, and the less (informational) entropy. The more variety there is, the more potential disorder.

So, the more elaborate a system becomes (i.e., the more information it stores – indeed, the more senescent it is – figures 3 and 4), the more is its behavior potentially disorderly and unpredictable. Informationally rich systems have a relatively large capacity for variety of pathological states, and these states are more frequently accessed as the system increasingly fails during senescence, because of its inflexibility, to recover from perturbations. In the neoanimistic developmental myth, then, the grand final cause of all forms and behavior is the necessity for the maximization of entropy [which may in turn be interpreted as the result of a physical drive toward material equilibration (Matsuno 1989)], and the typical final resolution of all particular natural forms is dissolution in the elaboration of senescence (informational entropy) and recycling by way of accessing more dangerous pathological states as they become more lost in behavioral disorder [I say "typical" here because the suggestion has been made that the formally senescent condition may be a requisite for the emergence of higher levels – Csányi and Kampis 1985 (integrative levels), Alvarez de Lorenzana, 1991, 1993 (scalar levels)].

#### 4. THE NEW CONDITION FOR MYTHOPOIESIS

Now, today, when reflexivity and recursiveness are major intellectual problems, we must further see that the image of the developmental trajectory depends upon we ourselves as observers of systems, because that trajectory, as shown in figure 8, serves to link us (each of us as individuals if we like) to all other particular dynamic phenomena. We have constructed this structure from the logic of our position in a specification hierarchy of integrative levels that results from the process of individuation during development. The general form of this trajectory was worked out (in the nineteenth century) by the North American scientist and philosopher, Charles Peirce. According to him (e.g., Esposito 1980, Raposa 1989), a system develops from an initial vague condition in which chance events are predominant (what I have referred to as an

immature condition) to a situation where an actual explicitly elaborated system exists in which habits predominate over creativity. In this same period another, more exhaustive but less profound, version of this myth was developed by Herbert Spencer. And this kind of image goes back to the earlier German romantic philosopher Schelling, who also worked it out in great detail (Esposito 1977).

What is important for us now is to see that this construct is just that – the product of human discourse. As such, it has a particular history – European and North American. It is a Dionesian, romantic, synthetic construct that gained a new lease on life by way of thermodynamics and information theory. And so we find that what appeared to be another universalist model of the world can readily be seen to be a European – indeed, mostly male – construct, and so is only one possible myth in our postmodern world. It does have all the force of history stretching from Aristotle to the present time (indeed, a longer history of hegemony than the myth associated with BCNDC science has had), during the latter part of which history it was represented in most scientific discourses as well – biology, anthropology, sociology, psychology, and so on (and it still survives in the last three).

Here we face a really new challenge: to believe – for example, in this myth that informs developmentalism (as I do because it allows us, by way of figure 8, to increase the range of our emotional commitments to all of nature) – even while we do not expect that our beliefs will find universal support in other anthropological structures. In other words, to believe we know even while we know that others may know something else. In the past we could believe we knew only because we were convinced that others were mistaken when they thought they knew something different. That arrogance cannot survive post-modernism.

It has seemed to some that it would be more gracious in such a relativist situation to profess, along with logical positivists, not to believe in anything, but we can now see that such a supposed abstention of belief itself implies further beliefs about the world [for examples, as I mentioned earlier, (1) belief that the world is a resource for human exploitation, (2) belief in mechanistic materialism, and (3) belief in competitive individualism]. To not believe is associated with these beliefs, and these seem to be the very beliefs that have been associated with practices destructive of our environments. We now know that since we are believing entities, belief will survive postmodernism – but in what form?

## 5. CONCLUSION

To not believe is no longer an option, even though belief requires considerable stamina in the postmodern situation. But can we actually choose our beliefs? I believe we must (and they are there waiting, in the structure of discourses, as in the example I have given above), but it is not clear that we can. And yet, to believe while knowing that our belief is our own local construct is a feat that may perhaps be more difficult to describe explicitly (and logically) than to accomplish.

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