BY THE SAME AUTHOR

*A New Science of Life*
*The Rebirth of Nature*

# THE PRESENCE OF THE PAST

## MORPHIC RESONANCE & THE HABITS OF NATURE

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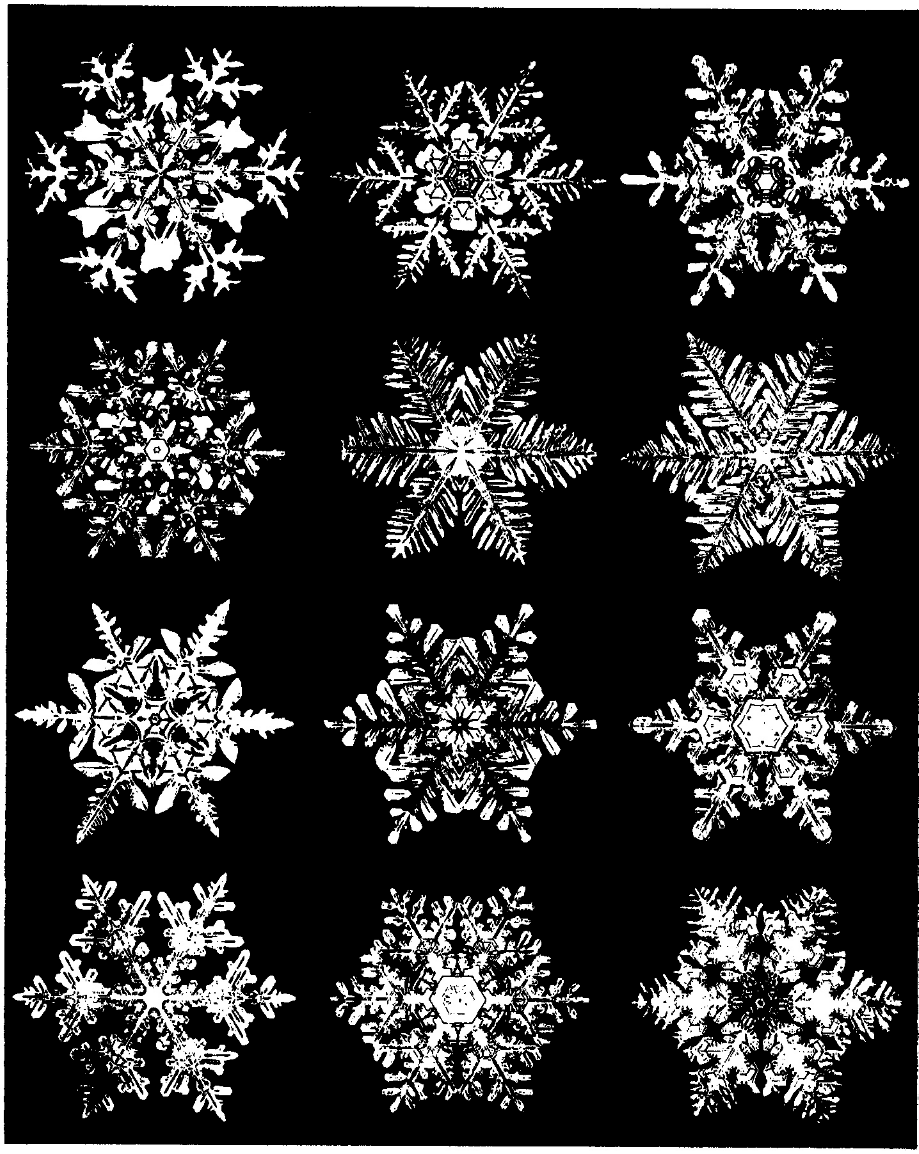

**Figure 7.3** Snowflakes. (From *Snow Crystals* by W. A. Bentley and W. J. Humphreys; Dover Publications, Inc., 1962. Reproduced by permission.)

From the point of view of the hypothesis of formative causation, the lattice structure is organized by a lattice morphic field, and a higher-level field organizes the structure of the crystal as a whole. The same lattice structure, for example that of water, can be organized into different types of crystal, as in sheets of ice, in snowflakes, and in various kinds of frost. The



morphic field of the crystal as a whole is associated with the "lattice vibrations which are exquisitely sensitive to the structure in which they occur" and organizes the pattern in which the crystal grows.

## *Crystallization Experiments*

The fields of crystals that have already occurred many times in the past are highly stabilized by morphic resonance, and changes in these fields will not be experimentally detectable. But this is not the case with newly synthesized chemicals that have never existed before. Thousands of new kinds of molecules are made every year by synthetic chemists in universities and in industrial laboratories. Before such a substance crystallizes for the first time, there will not be morphic fields either for its lattice structure, or for the form of the crystal as a whole. There can be no morphic resonance from previous crystals of this type if none have existed. But when it crystallizes for the first time, the lattice and the crystal fields come into being. The second time, the fields will be influenced by morphic resonance from the first crystals; the third time, from the first and second crystals; and so on. There will be a cumulative build-up of morphic resonance stabilizing the fields of subsequent crystals, which will tend to render further crystallization of this type more probable. Consequently, the compound should tend to crystallize more and more readily as more of the crystals are made.

It is in fact well known to chemists that newly synthesized compounds are usually difficult to crystallize: weeks or even months may elapse before crystals appear in a supersaturated solution. Moreover, generally speaking, compounds become easier to crystallize all over the world the more often they are made. This happens in part because chemists tell each other of the appropriate techniques. But the most common conventional explanation for this phenomenon is that fragments of previous crystals are carried around the world from laboratory to laboratory, where they serve as "seeds" for subsequent crystallizations. The folklore of chemistry has a rich store of anecdotes on this subject. The carriers of the seeds are often said to be migrant scientists, especially chemists with beards, which can "harbour nuclei for almost any crystallization process."[34] Or else seeds are thought to move around the world as microscopic dust particles in the atmosphere.

If morphic resonance plays a part in this phenomenon, the more often the new compounds are crystallized, the more readily they should tend to crystallize all over the world, even when migrant chemists are rigorously excluded and when dust particles are filtered out of the atmosphere. Experiments can easily be designed to test this prediction.[35]

### *Symmetry and Internal Resonance*

According to the hypothesis of formative causation, crystal structures are stabilized by morphic resonance from other crystals of the same kind that existed in the past. But, in addition, the symmetry of crystals such as snowflakes seems explicable only in terms of some kind of resonance *within* the growing crystal: such an explanation seems necessary whether or not we take morphic fields into account (pp. 129–31). This raises a very general point about the morphogenesis of symmetrical structures: their symmetry seems to require some kind of resonant communication between the symmetrical parts. Consider, for example, your right and left hands. They are different from everyone else's, in both the pattern of lines on the palms and the pattern of ridges on the finger-tips. Yet they are very similar to each other,[36] just as the arms of an individual snowflake are similar to each other. This suggests that within the developing organism morphic resonance takes place between similar structures, in this case between the fields of the embryonic hands. The same applies to other symmetrical structures such as the right and left sides of the face: again, although these are not exactly the same, they are very similar, and their development must have been correlated by some kind of resonant phenomenon.

We may conclude that in general within developing organisms there is an internal resonance between the fields of symmetrical structures, and this self-resonance is essential to their symmetry. Since symmetry is such an important feature of natural forms at every level of complexity, an internal resonance between symmetrical structures within the same organism is likely to be an important general feature of formative causation through morphic fields.

Such morphic resonance between spatially symmetrical structures that are developing at the same time within the same organism is, however, only one kind of self-resonance. Another aspect of self-resonance which is just as fundamental is the morphic resonance from an organism's own past.

### *Self-Resonance*

The specificity of morphic resonance depends on the similarity of the patterns of activity that are resonating. The more similar the patterns of activity, the more specific and effective will the resonance be. In general, the most specific morphic resonance acting on a given organism will be that from its *own* past states, because it is more similar to itself in the past, especially in the immediate past, than to any other organism. This self-resonance will therefore tend to stabilize and maintain organisms in their own characteristic



form, as well as harmonizing the development of symmetrical structures within the same organism. In living organisms, this self-stabilization of morphic fields may go a long way towards explaining how they are able to maintain their characteristic forms in spite of a continuous turnover of their chemical constituents.

If resonance from a holon's own past states is of such importance, then how far in the past does a pattern of activity have to be to exert an influence by morphic resonance? The very notion of resonance implies a relationship between vibratory structures of activity, and the identity of such a structure cannot be defined instantaneously. Its "present" must involve duration, since vibrations take time; and the frequency of vibration cannot be characterized until several similar vibrations have taken place. The "present" must therefore consist of several cycles of vibration; hence the duration of the present depends on the characteristic vibratory frequencies of the organism. The slower these are, the longer the "present" will be.

This general principle is, of course, apparent in quanta of radiation and of matter, which because of their wavelike nature cannot be considered to be sharply located: they are more like a "smear" of probability. There is an inherent uncertainty in locating them at a particular point and assigning them a particular momentum.

In quantum matter fields, the vibration of the field itself underlies the quanta, or particles. The field, as the ground of the vibration, must endure or persist in time; indeed persistence in time, which implies a linkage of the present with the past, is inherent in the nature of the field. This linkage cannot take place through any kind of independently persisting material structure, since particles of matter are themselves manifestations of the field. So if a vibrating field is connected to its own past, which it must be if it is to persist, the linkage must be intrinsically temporal in nature. It must in fact depend on some kind of self-resonance.

Just as the position and momentum of a particle cannot be defined with certainty, neither can the exact duration of its present: it shades off into the past. These past patterns of activity into which it shades off become present again by morphic resonance, and by doing so maintain and stabilize the field as it persists in time.

If this interpretation is valid, then the persistence of matter itself, and indeed of radiation, depends on a continuous process of resonance of the fields with their own past states. The continuity of any self-organizing pattern of activity at any level of complexity—from an electron to an elephant—results from this self-resonance with its own past patterns of activity. All organisms are dynamic structures that are continuously recreating themselves under the influence of their own past states.

These causal influences from an organism's own past states must be capable of passing through or across not only time but space, or rather space-time. This requirement becomes obvious when we consider a moving organism, for example a galloping horse: its past patterns of activity with which it is in morphic resonance occurred in different places from the ones it now occupies. If it is in morphic resonance with its own past states, including those of only a few seconds ago, this causal influence must traverse the intervening space-time. Or, to look at it another way, its past patterns of activity, wherever and whenever they were, can become present by morphic resonance.

Thus morphic resonance from the patterns of activity of similar past organisms, and self-resonance from an organism's own past, can be seen as different aspects of the same process. Both involve formative causal connections across both space and time. Self-resonance, through its high specificity, stabilizes an organism's own characteristic pattern of activity, and resonance with similar past organisms stabilizes the general probability structure of the field. This is what enables an organism to come into being and gives it its potentialities. As it actualizes itself, its own particular structure will tend to be maintained by self-resonance within the overall probability structure of the field.

This interpretation has much in common with Whitehead's idea that there is a "prehension" from the "actual occasions" of organisms to their immediate or more remote predecessors. The more often a pattern of activity has been repeated, the stronger its influence will be. In Whitehead's words, "any likeness between the successive occasions of a historical route procures a corresponding identity between their contributions to the datum of any subsequent actual entity; and it therefore secures a corresponding intensification in the imposition of conformity."[37] However, Whitehead's philosophy is rather obscure in this respect; and although he definitely envisaged a process similar to what is here called self-resonance, it is not clear to what extent he thought of a comparable influence from *different* organisms in the past.[38]

In chapter 6 we considered the role of morphic fields in biological morphogenesis, and in this chapter their role in the morphogenesis of molecules and crystals. We have also examined some of the general features of the hypothesis of formative causation: the idea of morphic fields as probability structures, and the importance of self-resonance in the development and maintenance of the form of individual organisms. We now turn to a discussion of the possible role of morphic resonance in biological heredity, and then in chapter 9 consider the nature of animal memory and the light shed upon it by the idea of self-resonance from an animal's own patterns of activity in the past.

# CHAPTER 8

# Biological Inheritance

### *Genes and Fields*

Living organisms inherit genes from their ancestors. According to the hypothesis of formative causation, they also inherit morphic fields. Heredity depends on both genes and morphic resonance.

The conventional theory attempts to squeeze all the hereditary characteristics of organisms into their genes. Development is then understood as the *expression* of these genes through the synthesis of proteins and other molecules. The words *hereditary* and *genetic* are treated as synonyms. Thus inherited characteristics, such as the ability of an acorn to grow into an oak tree or of a wren to build a nest, are usually referred to as genetic, or as genetically programmed.

What is in fact known to be inherited genetically is DNA. Some of the DNA codes for the sequence of amino acids in proteins; some codes for RNA such as that found in ribosomes; and some is involved in the control of gene expression. However, in higher organisms only a small percentage of the DNA (in humans, about 1%) seems to be involved in such coding and genetic control. The function, if any, of the vast majority is unknown, although some probably plays an important structural role in the chromosomes. Furthermore, the total amount of DNA that is inherited seems to bear very little relationship to the complexity of the organism. Among the amphibians, for instance, some species have one hundred times more DNA than others; and the cells of lily plants contain about thirty times more DNA than human cells.[1]

There is also a poor correlation between the genetic differences between species and the form and behaviour of these species. Thus, for example, On the present hypothesis, over and above the behavioural fields of individual insects are the morphic fields of the society as a whole, which co-ordinate the activities of the individuals. These fields are spatially extended and embrace the entire colony; the individuals live within them. It is through these supra-individual fields that the colony comes into being and maintains its structure and organization, in spite of the continual turnover of individual workers, whose life-span is generally much shorter than that of the colony as a whole. The self-organizing properties of these fields are what enable the colonies to adjust to accidents, damage, and environmental fluctuations and to repair their nests.

The need for some such concept can be illustrated by considering the way in which termites construct their nests, which can reach enormous sizes and in some species are extremely complex, even incorporating what can only be described as an air-conditioning system.

The African fungus-growing termite *Macrotermes natalensis* forms vast colonies that last for years and at maturity contain about two million insects at any one time. The nest develops from a small underground chamber made by the royal couple, and can grow to a height of over ten feet above the ground. At the base of the mound is the nest proper, with the royal cell in its centre. In its many chambers, which are connected by numerous passages, are masses of finely chewed wood, on which the termites cultivate the fungus that they eat. Above this there is a large air space, and this is enclosed by the outer casing of the mound, on the outside of which are ridges or buttresses. Channels as thick as a man's arm radiate into many small ducts within the buttresses. The air in the fungus chambers is heated by the fermentation process and by the termites themselves; this hot air rises and is forced into the duct system of the ridges, the walls of which are so porous that they allow gas exchange to take place: carbon dioxide escapes and oxygen penetrates from the outside. From these "lungs," the cooled and regenerated air now flows back down another system of wide ducts into the cellar, whence it returns to the nest.[7]

These structures are built by workers from pellets of soil which are glued together with excrement or saliva. But how do they know where to put these materials? In the words of E. O. Wilson:

> It is all but impossible to conceive how one colony member can oversee more than a minute fraction of the work or envision in its entirety the plan of such a finished product. Some of these nests require many worker lifetimes to complete, and each new addition must somehow be brought into a proper relationship with the previous parts. The existence of such nests leads inevitably to the conclusion that the workers interact in a very orderly and predictable manner. But how can the workers communicate so effectively over such long periods of time? Also, who has the blueprint of the nest?[8]



Detailed observations of the building activity have shown that the nest structure that has been completed, more than direct communication among the insects, influences what work will be done. For example, in the building of arches, workers first construct columns, and then if another column is being built sufficiently close by, they bend the column towards the other one (Fig. 13.3) until the tilted growing ends of the two columns meet.[9] No one knows how they do this. The workers cannot see the other column: they are blind. There is no evidence that they run back and forth at the base of the columns measuring the distance. Moreover, "it is improbable that in the midst of all the confused scampering in the vicinity, they can recognize distinct sounds from the column by conduction through the substrate."[10] By a process of elimination, it is generally assumed that they must be able to locate the other column by somehow smelling it.[11]

In short, very little is actually understood about the way in which the termites construct these prodigious structures. Moreover, the conventional

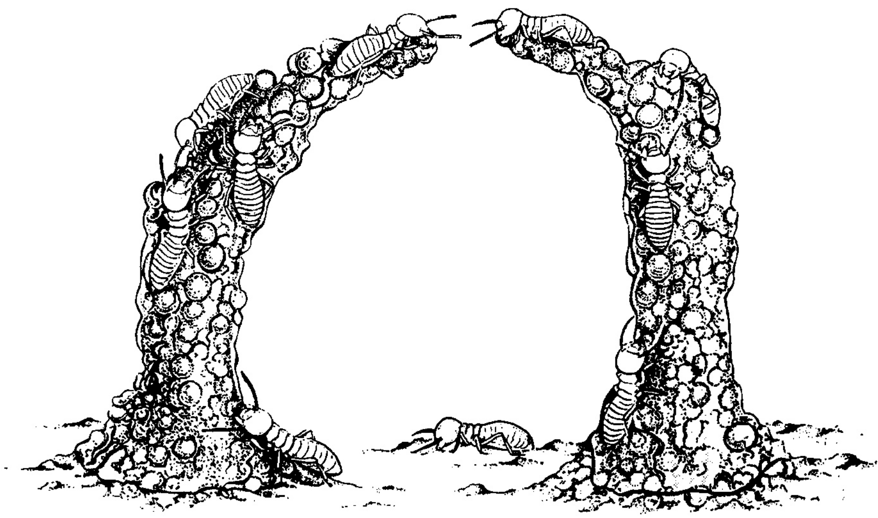

**Figure 13.3** The construction of an arch by workers of the termite species *Macrotermes natalensis.* Each column is built up from pellets of soil and excrement, carried by the insects in their mandibles. When the column reaches a certain height, the termites, which are blind, begin to extend it at an angle towards a neighbouring column. (From *Animal Architecture* by Karl von Frisch, illustrated by Turid Holldobler. Copyright © 1974 by Turid Holldobler. Reprinted by permission of Harcourt Brace Jovanovich, Inc.)

idea that instinctive abilities are somehow "programmed" or "hard-wired" in the nervous system might lead us to expect that termites that build such complex nests have larger and more complex nervous systems than species that build much simpler nests. But in fact they do not.[12]

The hypothesis of formative causation provides an alternative approach, and suggests that the structures of the nests are organized by morphic fields embracing the nests as wholes, with a nested hierarchy of fields within them associated with the various elements of the overall structure. These fields are not inside the individual termites; rather the individual insects are inside the social fields.

If this is so, the organizing activity of the fields would extend beyond the range over which individual insects can communicate with each other by smell or by mechanical means. This idea is experimentally testable, and indeed there is already suggestive evidence that some such effects occur.

Over sixty years ago, the South African naturalist Eugene Marais made a series of observations on the way in which the workers of the species *Eutermes* repaired large breaches that he made in their mounds. He was struck by the way the workers set to work on the breach from every side and yet worked in a co-ordinated way so that the new parts all joined correctly, even though termites working on different sides of the breach did not come into contact with each other and, being blind, could not see each other.

He then carried out a simple but remarkable experiment. He took a large steel plate several feet wider and higher than the termitary and drove it right through the centre of the breach in such a way that it divided the mound and indeed the entire termitary into two separate parts.

> The builders on one side of the breach know nothing of those on the other side. In spite of this the termites build a similar arch or tower on each side of the plate. When eventually you withdraw the plate, the two halves match perfectly after the dividing cut has been repaired. We cannot escape the ultimate conclusion that somewhere there exists a preconceived plan which the termites merely execute.[13]

The same thing happened when the steel plate was driven in first and then a breach was made on either side of it.

Apparently this fascinating experiment has never been repeated; it would obviously be well worth doing so, preferably using material that would provide better acoustic insulation than a steel plate.

Marais thought that the queen was like the "brain" of the colony and was somehow connected with the entire colony directly, over and above the chemical and other influences that were physically carried to other members of the colony by the workers who tended her. On the present hypothesis, such a linkage could be thought of in terms of the extended morphic field embracing both the queen and all the other members of the colony. Marais claimed to have demonstrated the existence of such non-material connections by means of simple experiments such as the following:



> While the termites are carrying out their work of restoration on either side of the steel plate, dig a furrow enabling you to reach the queen's cell, disturbing the nest as little as possible. Expose the queen and destroy her. Immediately the whole community ceases work on either side of the plate.[14]

Again, no further work seems to have been done along these lines; but clearly it would be of interest to find out just how immediate this effect is; for an effect mediated by the morphic field of the colony could be immediate, whereas an effect that depended only on normal sensory communication could not. In such experiments it would not be necessary to kill the queen; merely removing her from the colony would probably suffice.

Probably it is with termites or other social insects that the most decisive experiments could be done to distinguish between the field approach to animal societies and the conventional mechanistic approach.

## *Schools, Flocks, and Herds*

In vertebrates too the co-ordination of individuals within a group is sometimes so close that it is almost impossible not to think of them as a kind of composite organism.

Many species of fish form schools or shoals.

> At a distance a fish school resembles a large organism. Its members, numbering anywhere from two or three into the millions, swim in tight formations, wheeling and reversing in near unison. Either dominance systems do not exist or are so weak as to have little or no influence on the dynamics of the school as a whole. When the school turns to the right or left, individuals formerly on the flank assume the lead.[15]

Schools exhibit characteristic patterns of behaviour, particularly in response to potential predators. When under attack, a school may respond by leaving a gaping hole or vacuole around the predator (Fig. 13.4). More often the school splits in half and the two halves turn outwards, eventually swimming back around the predator and rejoining. This is known as the fountain effect, and leaves the predator ahead of the school. Each time the predator turns, the same thing happens.