MIND AND NATURE

A Necessary Unity

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"Insofar as we are a mental process, to that same extent we must expect the natural world to show similar characteristics of mentality."

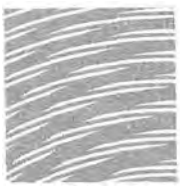
I

INTRODUCTION

* A large part of this chapter was delivered as a lecture at the Cathedral of Saint John the Divine in New York on November 17, 1977.

Plotinus the Platonist proves by means of the blossoms and leaves that from the Supreme God, whose beauty is invisible and ineffable, Providence reaches down to the things of earth here below. He points out that these frail and mortal objects could not be endowed with a beauty so immaculate and so exquisitely wrought, did they not issue from the Divinity which endlessly pervades with its invisible and unchanging beauty all things.

— SAINT AUGUSTINE, *The City of God*



In June 1977, I thought I had the beginnings of two books. One I called *The Evolutionary Idea* and the other *Every Schoolboy Knows.** The first was to be an attempt to reexamine the theories of biological evolution in the light of cybernetics and information theory. But as I began to write that book, I found it difficult to write with a real audience in mind who, I could hope, would understand the formal and therefore simple presuppositions of what I was saying. It became monstrously evident that schooling in this country and in England and, I suppose, in the entire Occident was so careful to avoid all crucial issues that I would have to write a second book to explain what seemed to me

*A favorite phrase of Lord Macaulay's. He is credited with, "Every schoolboy knows who imprisoned Montezuma, and who strangled Atahualpa."

elementary ideas relevant to evolution and to almost any other biological or social thinking — to daily life and to the eating of breakfast. Official education was telling people almost nothing of the nature of all those things on the seashores and in the redwood forests, in the deserts and the plains. Even grown-up persons with children of their own cannot give a reasonable account of concepts such as entropy, sacrament, syntax, number, quantity, pattern, linear relation, name, class, relevance, energy, redundancy, force, probability, parts, whole, information, tautology, homology, mass (either Newtonian or Christian), explanation, description, rule of dimensions, logical type, metaphor, topology, and so on. What are butterflies? What are starfish? What are beauty and ugliness?

It seemed to me that the writing out of some of these very elementary ideas could be entitled, with a little irony, *"Every Schoolboy Knows."*

But as I sat in Lindisfarne working on these two manuscripts, sometimes adding a piece to one and sometimes a piece to the other, the two gradually came together, and the product of that coming together was what I think is called a *Platonic* view.* It seemed to me that in *"Schoolboy,"* I was laying down very elementary ideas about *epistemology* (see Glossary), that is, about *how we can know anything.* In the pronoun *we,* I of course included the starfish and the redwood forest, the segmenting egg, and the Senate of the United States.

And in the *anything* which these creatures variously know, I included "how to grow into five-way symmetry," "how to survive a forest fire," "how to grow and still stay the same shape," "how to learn," "how to write a constitution," "how to invent and drive a car," "how to count to seven," and so on. Marvelous creatures with almost miraculous knowledges and skills.

Above all, I included "how to evolve," because it seemed to me that both evolution and learning must fit the same formal regularities or so-called laws. I was, you see, starting to use the ideas of *"Schoolboy"* to

* Plato's most famous discovery concerned the "reality" of ideas. We commonly think that a dinner plate is "real" but that its circularity is "only an idea." But Plato noted, first, that the plate is not truly circular and, second, that the world can be perceived to contain a very large number of objects which simulate, approximate, or strive after "circularity." He therefore asserted that "circularity" is ideal (the adjective derived from idea) and that such ideal components of the universe are the real explanatory basis for its forms and structure. For him, as for William Blake and many others, that "Corporeal Universe" which our newspapers consider "real" was some sort of spin-off from the truly real, namely the forms and ideas. In the beginning was the idea.

reflect, not upon our own knowing, but upon that *wider knowing* which is the glue holding together the starfishes and sea anemones and redwood forests and human committees.

My two manuscripts were becoming a single book because there is a single knowing which characterizes evolution as well as *aggregates* of humans, even though committees and nations may seem stupid to two-legged geniuses like you and me.

I was transcending that line which is sometimes supposed to enclose the human being. In other words, as I was writing, mind became, for me, a reflection of large parts and many parts of the natural world outside the thinker.

On the whole, it was not the crudest, the simplest, the most animalistic and primitive aspects of the human species that were reflected in the natural phenomena. It was, rather, the more complex, the aesthetic, the intricate, and the elegant aspects of people that reflected nature. It was not my greed, my purposiveness, my so-called "animal," so-called "instincts," and so forth that I was recognizing on the other side of that mirror; over there in "nature." Rather, I was seeing there the roots of human symmetry, beauty and ugliness, aesthetics, the human being's very aliveness and little bit of wisdom. His wisdom, his bodily grace, and even his habit of making beautiful objects are just as "animal" as his cruelty. After all, the very word "animal" means "endowed with mind or spirit *(animus).*"

Against this background, those theories of man that start from the most animalistic and maladapted psychology turn out to be improbable first premises from which to approach the psalmist's question: "Lord, What is man?"

I never could accept the first step of the Genesis story: "In the beginning the earth was without form and void." That primary *tabula rasa* would have set a formidable problem in thermodynamics for the next billion years. Perhaps the earth never was any more a *tabula rasa* than is, a human zygote -- a fertilized egg.

It began to seem that the old-fashioned and still-established ideas about epistemology, especially human epistemology, were a reflection of an obsolete physics and contrasted in a curious way with the little we seem to know about living things. It was as if members of the species, man, were supposed to be totally unique and totally material-

istic against the background of a living universe which was generalized (rather than unique) and spiritual (rather than materialistic).

There seems to be something like a Gresham's law of cultural evolution according to which the oversimplified ideas will always displace the sophisticated and the vulgar and hateful will always displace the beautiful. And yet the beautiful persists.

It began to seem as if organized matter —— and I know nothing about unorganized matter, if there be any —— in even such a simple set of relations as exists in a steam engine with a governor was wise and sophisticated compared with the picture of human spirit that orthodox materialism and a large part of orthodox religion currently drew.

The germ of these ideas had been in my mind since I was a boy. But let me start from two contexts in which these thoughts began to insist on utterance: In the 1950s, I had two teaching tasks. I was teaching psychiatric residents at a Veterans Administration mental hospital in Palo Alto and young beatniks in the California School of Fine Arts in San Francisco. I want to tell you how those two courses commenced, how I approached those two contrasting audiences. If you put these two first lectures side by side, you will see what I am trying to say.

To the psychiatrists, I presented a challenge in the shape of a small exam paper, telling them that by the end of the course they should understand the questions in it. Question 1 asked for brief definitions of (a) "sacrament" and (b) "entropy."

The young psychiatrists in the 1950s were, in general, unable to answer either question. Today, a few more could begin to talk about entropy (see Glossary). And I suppose there are still some Christians who could say what a sacrament is?

I was offering my class the core notions of 2,500 years of thought about religion and science. I felt that if they were going to be doctors (medical doctors) of the human soul, they should at least have a foot on each side of the ancient arguments. They should be familiar with the central ideas of both religion and science.

For the art students, I was more direct. It was a small group of about ten to fifteen students, and I knew that I would be walking into an atmosphere of skepticism bordering on hostility. When I entered it

was clear that I was expected to be an incarnation of the devil, who would argue for the common sense of atomic warfare and pesticides. In those days (and even today?), science was believed to be "value-free" and not guided by "emotions."

I was prepared for that. I had two paper bags, and the first of these I opened, producing a freshly cooked crab, which I placed on the table. I then challenged the class somewhat as follows: "I want you to produce arguments which will convince me that this object is the remains of a living thing. You may imagine, if you will, that you are Martians and that on Mars you are familiar with living things, being indeed yourselves alive. But, of course, you have never seen crabs or lobsters. A number of objects like this, many of them fragmentary, have arrived, perhaps by meteor. You are to inspect them and arrive at the conclusion that they are the remains of living things. How would you arrive at that conclusion?"

Of course, the question set for the psychiatrists was the *same question* as that which I set for the artists: Is there a biological species of entropy?

Both questions concerned the underlying notion of a dividing line between the world of the living (where *distinctions* are drawn and *difference* can be a cause) and the world of nonliving billiard balls and galaxies (where forces and impacts are the "causes" of events). These are the two worlds that Jung (following the Gnostics) calls *creatura* (the living) and *pleroma* (the nonliving).* I was asking: What is the difference between the physical world of pleroma, where forces and impacts provide sufficient basis of explanation, and the *creatura,* where nothing can be understood until *differences* and *distinctions* are invoked?

In my life, I have put the descriptions of sticks and stones and billiard balls and galaxies in one box, the pleroma, and have left them alone. In the other box, I put living things: crabs, people, problems of beauty, and problems of difference. The contents of the second box are the subject of this book.

I was griping recently about the shortcomings of occidental education. It was in a letter to my fellow regents of the University of California, and the following phrase crept into my letter:

* C. G. Jung, *Septem Sermones ad Mortuos* (London: Stuart & Watkins, 1967).

"Break the pattern which connects the items of learning and you necessarily destroy all quality."

I offer you the phrase *the pattern which connects* as a synonym, another possible title for this book.

The pattern which connects. Why do schools teach almost nothing of the pattern which connects? Is it that teachers know that they carry the kiss of death which will turn to tastelessness whatever they touch and therefore they are wisely unwilling to touch or teach anything of real-life importance? Or is it that they carry the kiss of death *because* they dare not teach anything of real-life importance? What's wrong with them?

What pattern connects the crab to the lobster and the orchid to the primrose and all the four of them to me? And me to you? And all the six of us to the amoeba in one direction and to the back-ward schizophrenic in another?

I want to tell you why I have been a biologist all my life, what it is that I have been trying to study. What thoughts can I share regarding the total biological world in which we live and have our being? How is it put together?

What now must be said is difficult, appears to be quite *empty,* and is of very great and deep importance to you and to me. At this historic juncture, I believe it to be important to the survival of the whole biosphere, which you know is threatened.

What is the pattern which connects all the living creatures?

Let me go back to my crab and my class of beatniks. I was very lucky to be teaching people who were not scientists and the bias of whose minds was even antiscientific. All untrained as they were, their bias was aesthetic. I would define that word, for the moment, by saying that they were *not* like Peter Bly, the character of whom Wordsworth sang

A primrose by the river's brim
A yellow primrose was to him;
And it was nothing more.

Rather, they would meet the primrose with *recognition* and *empathy.* By *aesthetic,* I mean responsive to *the pattern which connects.* So you see, I was

lucky. Perhaps by coincidence, I faced them with what was (though I knew it not) an aesthetic question: *How are you related to this creature? What pattern connects you to it?*

By putting them on an imaginary planet, "Mars," I stripped them of all thought of lobsters, amoebas, cabbages, and so on and forced the diagnosis of life back into identification with living self: *"You* carry the bench marks, the criteria, with which you could look at the crab to find that it, too, carries the same marks." My question was much more sophisticated than I knew.

So they looked at the crab. And first of all, they came up with the observation that it is *symmetrical;* that is, the right side resembles the left.

"Very good. You mean it's *composed,* like a painting?" (No response.)

Then they observed that one claw was bigger than the other. So it was *not* symmetrical.

I suggested that if a number of these objects had come by meteor, they would find that in almost all specimens it was the same side (right or left) that carried the bigger claw. (No response. "What's Bateson getting at?")

Going back to symmetry, somebody said that "*yes, one claw is bigger than the other, but both claws are made of the same parts.*"

Ah! What a beautiful and noble statement that is, how the speaker politely flung into the trash can the idea that *size* could be of primary or profound importance and went after the *pattern which connects.* He discarded an asymmetry in size in favor of a deeper symmetry in formal relations.

Yes, indeed, the two claws are characterized (ugly word) by embodying *similar relations between parts.* Never quantities, always shapes, forms, and relations. This was, indeed, something that characterized the crab as a member of *creatura,* a living thing.

Later, it appeared that not only are the two claws built on the same "ground plan," (i.e., upon corresponding sets of relations between corresponding parts) but that these relations between corresponding parts extend down the series of the walking legs. We could recognize in every leg pieces that corresponded to the pieces in the claw.

And in your own body, of course, the same sort of thing is true.

Humerus in the upper arm corresponds to femur in the thigh, and radius-ulna corresponds to tibia-fibula; the carpals in the wrist correspond to tarsals in the foot; fingers correspond to toes.

The anatomy of the crab is repetitive and rhythmical. It is, like music, repetitive with modulation. Indeed, the direction from head toward tail corresponds to a sequence in time: In embryology, the head is older than the tail. A flow of information is possible, from front to rear.

Professional biologists talk about phylogenetic *homology* (see Glossary) for that class of facts of which one example is the formal resemblance between my limb bones and those of a horse. Another example is the formal resemblance between the appendages of a crab and those of a lobster.

That is one class of facts. Another (somehow similar?) class of facts is what they call *serial homology.* One example is the rhythmic repetition with change from appendage to appendage down the length of the beast (crab or man); another (perhaps not quite comparable because of the difference in relation to time) would be the bilateral symmetry of the man or crab.*

Let me start again. The parts of a crab are connected by various patterns of bilateral symmetry, of serial homology, and so on. Let us call these patterns within the individual growing crab *first-order connections.* But now we look at crab and lobster and we again find connection by pattern. Call it *second-order connection*, or phylogenetic homology.

Now we look at man or horse and find that, here again, we can see symmetries and serial homologies. When we look at the two together, we find the same cross-species sharing of pattern with a difference (phylogenetic homology). And, of course, we also find the same discarding of magnitudes in favor of shapes, patterns, and relations. In

*In the serial case it is easy to imagine that each anterior segment may give information to the next segment which is developing immediately behind it. Such information might determine orientation, size, and even shape of the new segment. After all, the anterior is also antecedent in time and could be the quasi-logical antecedent or model for its successor. The relation between anterior and posterior would then be asymmetrical and complementary. It is conceivable and even expectable that the symmetrical relation between right and left is doubly asymmetrical, i.e., that each has some complementary control over the development of the other. The pair would then constitute a circuit of ***reciprocal*** control. It is surprising that we have almost no knowledge of the vast system of communication which must surely exist to control growth and differentiation.

other words, as this distribution of formal resemblances is spelled out, it turns out that gross anatomy exhibits three levels or logical types of descriptive propositions:

1. The parts of any member of *Creatura* are to be compared with other parts of the same individual to give first-order connections.

2. Crabs are to be compared with lobsters or men with horses to find similar relations between parts (i.e., to give second-order connections).

3. The *comparison* between crabs and lobsters is to be compared with the comparison between man and horse to provide third-order connections.

We have constructed a ladder of how to think about--about what? Oh, yes, the pattern which connects.

My central thesis can now be approached in words: The *pattern which connects is a metapattern.* It is a pattern of patterns. It is that metapattern which defines the vast generalization that, indeed, *it is patterns which connect.*

I warned some pages back that we would encounter emptiness, and indeed it is so. Mind is empty; it is no-thing. It exists only in its ideas, and these again are no-things. Only the ideas are immanent, embodied in their examples. And the examples are, again, no-things. The claw, *as an example,* is not the *Ding an sich;* it is precisely *not* the *"thing in itself."* Rather, it is what mind makes of it, namely, an *example* of something or other.

Let me go back to the classroom of young artists.

You will recall that I had *two* paper bags. In one of them was the crab. In the other I had a beautiful large conch shell. By what token, I asked them, could they know that the spiral shell had been part of a living thing?

When she was about seven, somebody gave my daughter Cathy a cat's-eye mounted as a ring. She was wearing it, and I asked her what it was. She said it was a cat's-eye.

I said, "But what *is* it?"

"Well, I know it's not the eye of a cat. I guess it's some sort of stone."

I said, "Take it off and look at the back of it."

She did that and exclaimed, "Oh, it's got a spiral on it! It must have belonged to something alive."

Actually, these greenish disks are the opercula (lids) of a species of tropical marine snail. Soldiers brought lots of them back from the Pacific at the end of World War II.

Cathy was right in her major premise that all spirals in this world except whirlpools, galaxies, and spiral winds are, indeed, made by living things. There is an extensive literature on this subject, which some readers may be interested in looking up (the key words are *Fibonacci series* and *golden section).*

What comes out of all this is that a spiral is a figure that *retains its shape (i.e., its proportions) as it grows* in one dimension by addition at the open end. You see, there are no truly static spirals.

But the class had difficulty. They looked for all the beautiful formal characteristics that they had joyfully found in the crab. They had the idea that formal symmetry, repetition of parts, modulated repetition, and so on were what teacher wanted. But the spiral was *not* bilaterally symmetrical; it was not segmented.

They had to discover (a) that all symmetry and segmentation were somehow a result, a payoff from, the fact of growth; and (b) that growth makes its formal demands; and (c) that one of these is satisfied (in a mathematical, an ideal, sense) by spiral form.

So the conch shell carries the snail's *prochronism*—its record of how, *in its own past,* it successively solved a formal problem in pattern formation (see Glossary). It, too, proclaims its affiliation under that pattern of patterns which connects.

So far, all the examples that I have offered—the patterns which have membership in the pattern which connects, the anatomy of crab and lobster, the conch, and man and horse—have been superficially static. The examples have been the frozen shapes, results of regularized change, indeed, but themselves finally fixed, like the figures in Keats' "Ode on a Grecian Urn":

> *Fair youth, beneath the trees, thou can'st not leave*
> *Thy song, nor ever can those trees be bare;*
> *Bold lover, never never canst thou kiss,*
> *Though winning near the goal-yet do not grieve;*

She cannot fade, though thou hast not thy bliss,
Forever wilt thou love, and she be fair!

We have been trained to think of patterns, with the exception of those of music, as fixed affairs. It is easier and lazier that way but, of course, all nonsense. In truth, the right way to begin to think about the pattern which connects is to think of it as *primarily* (whatever that means) a dance of interacting parts and only secondarily pegged down by various sorts of physical limits and by those limits which organisms characteristically impose.

There is a story which I have used before and shall use again: A man wanted to know about mind, not in nature, but in his private large computer. He asked it (no doubt in his best Fortran), "Do you compute that you will ever think like a human being?" The machine then set to work to analyze its own computational habits. Finally, the machine printed its answer on a piece of paper, as such machines do. The man ran to get the answer and found, neatly typed, the words:

THAT REMINDS ME OF A STORY

A story is a little knot or complex of that species of connectedness which we call *relevance.* In the 1960s, students were fighting for "relevance," and I would assume that any A is relevant to any B if both A and B are parts or components of the same "story."

Again we face connectedness at more than one level:

First, connection between A and B by virtue of their being components in the same story.

And then, connectedness between people in that all think in terms of stories. (For surely the computer was right. This is indeed how people think.)

Now I want to show that whatever the word *story* means in the story which I told you, the fact of thinking in terms of stories does not isolate human beings as something separate from the starfish and the sea anemones, the coconut palms and the primroses. Rather, if the world be connected, if I am at all fundamentally right in what I am saying, then *thinking in terms of stories* must be shared by all mind or minds, whether ours or those of redwood forests and sea anemones.

Context and relevance must be characteristic not only of all so-called behavior (those stories which are projected out into "action"), but also of all those internal stories, the sequences of the building up of the sea anemone. Its embryology must be somehow made of the stuff of stories. And behind that, again, the evolutionary process through millions of generations whereby the sea anemone, like you and like me, came to be--that process, too, must be of the stuff of stories. There must be relevance in every step of phylogeny and among the steps.

Prospero says, "We are such stuff as dreams are made on," and surely he is nearly right. But I sometimes think that dreams are only fragments of that stuff. It is as if the stuff of which we are made were totally transparent and therefore imperceptible and as if the only appearances of which we can be aware are cracks and planes of fracture in that transparent matrix. Dreams and percepts and stories are perhaps cracks and irregularities in the uniform and timeless matrix. Was this what Plotinus meant by an "invisible and unchanging beauty which pervades all things?"

What is a story that it may connect the As and Bs, its parts? And is it true that the general fact that parts are connected in this way is at the very root of what it is to be alive? I offer you the notion of context, of *pattern through time.*

What happens when, for example, I go to a Freudian psychoanalyst? I walk into and create something which we will call a *context* that is at least symbolically (as a piece of the world of ideas) limited and isolated by closing the door. The geography of the room and the door is used as a representation of some strange, nongeographic message.

But I come with stories—not just a supply of stories to deliver to the analyst but stories built into my very being. The patterns and sequences of childhood experience are built into me. Father did so and so; my aunt did such and such; and what they did was outside my skin. But whatever it was that I learned, my learning happened within my experiential sequence of what those important others—my aunt, my father—did.

Now I come to the analyst, this newly important other who must be viewed as a father (or perhaps an antifather) because nothing has meaning except it be seen as in some context. This viewing is called the *transference* and is a general phenomenon in human relations. It is a uni-

versal characteristic of all interaction between persons because, after all, the shape of what happened between you and me yesterday carries over to shape how we respond to each other today. And that shaping is, in principle, a *transference* from past learning.

This phenomenon of transference exemplifies the truth of the computer's perception that we think in stories. The analyst must be stretched or shrunk onto the Procrustean bed of the patient's childhood stories. But also, by referring to psychoanalysis, I have narrowed the idea of "story." I have suggested that it has something to do with *context*, a crucial concept, partly undefined and therefore to be examined.

And "context" is linked to another undefined notion called "meaning." Without context, words and actions have no meaning at all. This is true not only of human communication in words but also of all communication whatsoever, of all mental process, of all mind, including that which tells the sea anemone how to grow and the amoeba what he should do next.

I am drawing an analogy between context in the superficial and partly conscious business of personal relations and context in the much deeper, more archaic processes of embryology and homology. I am asserting that whatever the word *context* means, it is an appropriate word, the *necessary* word, in the description of all these distantly related processes.

Let us look at homology backwards. Conventionally, people prove that evolution occurred by citing cases of homology. Let me do the reverse. Let me assume that evolution occurred and go on to ask about the nature of homology. Let us ask what some organ is according to the light shed upon it by evolutionary theory.

What is an elephant's trunk? What is it phylogenetically? What did genetics tell it to be?

As you know, the answer is that the elephant's trunk is his "nose." (Even Kipling knew!) And I put the word "nose" in quotation marks because the trunk is being defined by an internal process of communication in growth. The trunk is a "nose" by a process of communication: it is the context of the trunk that identifies it as a nose. That which stands between two eyes and north of a mouth is a "nose," and that is that. It is the *context* that fixes the meaning, and it must surely be the receiving context that provides meaning for the genetic in-

structions. When I call that a "nose" and this a "hand" I am quoting--or misquoting—the developmental instructions in the growing organism, and quoting what the tissues which received the message thought the message intended.

There are people who would prefer to define noses by their "function"—that of smelling. But if you spell out those definitions, you arrive at the same place using a temporal instead of a spatial context. You attach meaning to the organ by seeing it as playing a given part in sequences of interaction between creature and environment. I call that a *temporal* context. The temporal classification cross-cuts the spatial classification of contexts. But in embryology, the first definition must always be in terms of formal relations. The fetal trunk cannot, in general, smell anything. Embryology is *formal.*

Let me illustrate this species of connection, this connecting pattern, a little further by citing a discovery of Goethe's. He was a considerable botanist who had great ability in recognizing the nontrivial (i.e., in recognizing the patterns that connect). He straightened out the vocabulary of the gross comparative anatomy of flowering plants. He discovered that a "leaf" is not satisfactorily defined as "a flat green thing" or a "stem" as "a cylindrical thing." The way to go about the definition—and undoubtedly somewhere deep in the growth processes of the plant, this is how the matter is handled—is to note that buds (i.e., baby stems) form in the angles of leaves. From that, the botanist constructs the definitions on the basis of the relations between stem, leaf, bud, angle, and so on.

"A stem is that which bears leaves."
"A leaf is that which has a bud in its angle."
"A stem is what was once a bud in that position,"

All that is— or should be--familiar. But the next step is perhaps new.

There is a parallel confusion in the teaching of language that has never been straightened out. Professional linguists nowadays may know what's what, but children in school are still taught nonsense. They are told that a "noun" is the "name of a person, place, or thing," that a "verb" is "an action word," and so on. That is, they are taught at a

tender age that the way to define something is by what it supposedly is in itself, not by its relation to other things.

Most of us can remember being told that a noun is "the name of a person, place, or thing." And we can remember the utter boredom of parsing or analyzing sentences. Today all that should be changed. Children could be told that a noun is a word having a certain relationship to a predicate. A verb has a certain relation to a noun, its subject. And so on. Relationship could be used as basis for definition, and any child could then see that there is something wrong with the sentence " 'Go' is a verb."

I remember the boredom of analyzing sentences and the boredom later, at Cambridge, of learning comparative anatomy. Both subjects, as taught, were torturously unreal. We *could* have been told something about the pattern which connects: that all communication necessitates context, that without context, there is no meaning, and that contexts confer meaning because there is classification of contexts. The teacher could have argued that growth and differentiation must be controlled by communication. The shapes of animals and plants are transforms of messages. Language is itself a form of communication. The structure of the input must somehow be reflected as structure in the output. Anatomy *must* contain an analogue of grammar because all anatomy is a transform of message material, which must be contextually shaped. And finally, *contextual shaping* is only another term for *grammar.*

So we come back to the patterns of connection and the more abstract, more general (and most empty) proposition that, indeed, there is a pattern of patterns of connection.

This book is built on the opinion that we are parts of a living world. I have placed as epigraph at the head of this chapter a passage from Saint Augustine in which the saint's epistemology is clearly stated. Today such a statement evokes nostalgia. Most of us have lost that sense of unity of biosphere and humanity which would bind and reassure us all with an affirmation of beauty. Most of us do not today believe that whatever the ups and downs of detail within our limited experience, the larger whole is primarily beautiful.

We have lost the core of Christianity. We have lost Shiva, the dancer of Hinduism whose dance at the trivial level is both creation and

destruction but in whole is beauty. We have lost Abraxas, the terrible and beautiful god of both day and night in Gnosticism. We have lost totemism, the sense of parallelism between man's organization and that of the animals and plants. We have lost even the Dying God.

We are beginning to play with ideas of ecology, and although we immediately trivialize these ideas into commerce or politics, there is at least an impulse still in the human breast to unify and thereby sanctify the total natural world, of which we are.

Observe, however, that there have been, and still are, in the world many different and even contrasting epistemologies which have been alike in stressing an ultimate unity and, although this is less sure, which have also stressed the notion that ultimate unity is *aesthetic.* The uniformity of these views gives hope that perhaps the great authority of quantitative science may be insufficient to deny an ultimate unifying beauty.

I hold to the presupposition that our loss of the sense of aesthetic unity was, quite simply, an epistemological mistake. I believe that that mistake may be more serious than all the minor insanities that characterize those older epistemologies which agreed upon the fundamental unity.

A part of the story of our loss of the sense of unity has been elegantly told in Lovejoy's *Great Chain of Being,** which traces the story from classical Greek philosophy to Kant and the beginnings of German idealism in the eighteenth century. This is the story of the idea that the world is/was timelessly created upon *deductive logic.* The idea is clear in the epigraph from *The City of God.* Supreme Mind, or Logos, is at the head of the deductive chain. Below that are the angels, then people, then apes, and so on down to the plants and stones. All is in deductive order and tied into that order by a premise which prefigures our second law of thermodynamics. The premise asserts that the "more perfect" can never be generated by the "less perfect."

In the history of biology, it was Lamarck† who inverted the great chain of being. By insisting that mind is immanent in living crea-

* Arthur O. Lovejoy, *The Great Chain of Being: A Study of the History of an Idea* (Cambridge: Harvard University Press, 1936).

†J.-B. Lamarck, *Philosophie Zoologique* (1809) translated as [Zoological philosophy: An exposition with regard to the natural history of animals, trans. Hugh Elliot] (New York & London: Hafner Press, 1963).

tures and could determine their transformations, he escaped from the negative directional premise that the perfect must always precede the imperfect. He then proposed a theory of "transformism" (which we would call *evolution*) which started from infusoria (protozoa) and marched upward to man and woman.

The Lamarckian biosphere was still a *chain*. The unity of epistemology was retained in spite of a shift in emphasis from transcendent Logos to immanent mind.

The fifty years that followed saw the exponential rise of the Industrial Revolution, the triumph of Engineering over Mind, so that the culturally appropriate epistemology for the *Origin of Species* (1859) was an attempt to exclude mind as an explanatory principle. Tilting at a windmill.

There were protests much more profound than the shrieks of the Fundamentalists. Samuel Butler, Darwin's ablest critic, saw that the denial of mind as an explanatory principle was intolerable and tried to take evolutionary theory back to Lamarckism. But that would not do because of the hypothesis (shared even by Darwin) of the "inheritance of acquired characteristics." This hypothesis—that the responses of an organism to its environment could affect the genetics of the offspring—was an error.

I shall argue that this error was specifically an epistemological error in logical typing and shall offer a definition of *mind* very different from the notions vaguely held by both Darwin and Lamarck. Notably, I shall assume that thought resembles evolution in being a stochastic (see Glossary) process.

In what is offered in this book, the hierarchic structure of thought, which Bertrand Russell called *logical typing,* will take the place of the hierarchic structure of the Great Chain of Being and an attempt will be made to propose a sacred unity of the biosphere that will contain fewer epistemological errors than the versions of that sacred unity which the various religions of history have offered. What is important is that, right or wrong, the epistemology shall be *explicit*. Equally explicit criticism will then be possible.

So the immediate task of this book is to construct a picture of how the world is joined together in its mental aspects. How do ideas, information, steps of logical or pragmatic consistency, and the like fit

together? How is logic, the classical procedure for making chains of ideas, related to an outside world of things and creatures, parts and wholes? Do ideas really occur in chains, or is this lineal (see Glossary) structure imposed on them by scholars and philosophers? How is the world of logic, which eschews "circular argument," related to a world in which circular trains of causation are the rule rather than the exception?

What has to be investigated and described is a vast network or matrix of interlocking message material and abstract tautologies, premises, and exemplifications.

But, as of 1979, there is no conventional method of describing such a tangle. We do not know even where to begin.

Fifty years ago, we would have assumed that the best procedures for such a task would have been either logical or quantitative, or both. But we shall see as every schoolboy ought to know that logic is precisely unable to deal with recursive circuits without generating paradox and that quantities are precisely not the stuff of complex communicating systems.

In other words, logic and quantity turn out to be inappropriate devices for describing organisms and their interactions and internal organization. The particular nature of this inappropriateness will be exhibited in due course, but for the moment, the reader is asked to accept as true the assertion that, as of 1979, there is no conventional way of explaining or even describing the phenomena of biological organization and human interaction.

John Von Neumann pointed out thirty years ago, in his *Theory of Games,* that the behavioral sciences lack any reduced model which would do for biology and psychiatry what the Newtonian particle did for physics.

There are, however, a number of somewhat disconnected pieces of wisdom that will aid the task of this book. I shall therefore adopt the method of Little Jack Horner, pulling out plums one after the other and exhibiting them side by side to create an array from which we can go on to list some fundamental criteria of mental process.

In Chapter 2, "Every Schoolboy Knows," I shall gather for the reader some examples of what I regard as simple necessary truths- necessary first if the schoolboy is ever to learn to think and then again

necessary because, as I believe, the biological world is geared to these simple propositions.

In Chapter 3 I shall operate in the same way but shall bring to the reader's attention a number of cases in which two or more information sources come together to give information of a sort different from what was in either source separately.

At present, there is no existing science whose special interest is the combining of pieces of information. But I shall argue that the evolutionary process must depend upon such double increments of information. Every evolutionary step is an addition of information to an already existing system. Because this is so, the combinations, harmonies, and discords between successive pieces and layers of information will present many problems of survival and determine many directions of change.

Chapter 4, "The Criteria of Mind," will deal with the characteristics that in fact always seem to be combined in our earthly biosphere to make mind. The remainder of the book will focus more narrowly on problems of biological evolution.

Throughout, the thesis will be that it is possible and worthwhile to *think* about many problems of order and disorder in the biological universe and that we have today a considerable supply of tools of thought which we do not use, partly because—professors and schoolboys alike—we are ignorant of many currently available insights and partly because we are unwilling to accept the necessities that follow from a clear view of the human dilemmas.