PIOTR LENARTOWICZ SJ
JOLANTA KOSZTEYN

ON SOME PROBLEMS CONCERNING OBSERVATION OF BIOLOGICAL SYSTEMS

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INTRODUCTION

We propose to discuss some basic descriptive concepts used in biological observation. We believe that the current descriptive methods give an inadequate insight into the essential properties of living things. Our objections are numerous.

Our first objection concerns the current language of biology. The words „whole", „part", „system", „integration", „disintegration" are used without any definite illustration and without any unambiguous definition of their meaning. This produces an illusion that a „biological system" can be represented, for instance, by a beautiful, symmetric snowflake. In addition, it is difficult to grasp whether those words refer to an empirical reality or just to mental structures constructed by a learned observer. Those words, moreover, are usually missing among the entries of philosophical encyclopedias, dictionaries and textbooks – their meaning being taken for granted.

Our second objection is that – according to a current, tacit, but clearly distinguishable methodological „principle" – every descriptive abstract idea has to exclude any irreducible difference between living beings and dead, physical matter. In this way the question of the supposed reducibility is „solved" *a priori,* independently of the empirical data. Sometimes this „principle of reducibility" is treated as a meta-methodological assumption, inherent in the very definition of „scientific" cognition. Consequently, the meaning of the term „scientific cognition" is monopolized by a rather limited metaphysical belief and, at the same time, it becomes immune from any criticism based upon observational data.

Moreover, the above „principle" is detrimental to the selection of objects for study. Suppose, one intends, for instance, to study phenomena of locomotion. According to a common, and legitimate practice one has to select the „correct model". The „principle" we are opposing allows one to select the movement of the clouds in the sky instead of the movements of a bird in the sky.

Our third objection is raised against another quite widespread assumption, namely, that any real (empirically detectable) activity has to be reduced to the pattern of physico-chemical causality (influence/effect relation). In other words only one, single pattern of activity is recognized, with no other form of dynamism being seen as *a priori* conceptually, scientifically permissible. This assumption does not prevent the empirical sciences from collecting new, relevant data. It merely acts as a sieve, restricting our cognitive capacity to a narrow, fragmentary sector of biological phenomena. The main catastrophic consequence appears to be the „physical theory of cognition". „Physical" means „causal", i. e., reduced to the influence/effect phenomena. Whoever takes this strange theory for granted must, consequently, accept several skeptical arguments, tenets that during the last centuries, have dug an abyss between empirical and theoretical knowledge[1].

Our fourth objection against the current „rules of scientific description" concerns a bias in favor of assemblies rather than units. „Assemblies" of identical or almost identical units are selected and treated more attentively than the units themselves. For instance, the dynamism of a multitude of chemical compounds, or the dynamism of a „whole" *Drosophila* population is examined and pondered with care, while the complex dynamism of the integrative epigenesis within a single life cycle is usually skipped, disregarded, hardly mentioned.

Primary Errors

Two fundamental cognitive errors have to be mentioned in this context.

The first primary cognitive error (the „error of negation") consists in a refusal to see what is obvious, clear and objective. In the past there were observers who did not see what was and still is clearly visible to everybody. Who, for instance, could surpass David Hume! He did not notice any causal influence between two colliding billiard balls! In our times the disputable unity of the Earth („Gaia"), or the secondary relations within the ecological systems seem to many absolutely evident (which is good), while the primary complex integrative dynamisms and dynamic relations within a single organism are often hardly noticed and seldom mentioned – and that is wrong. Because of this error the description of some key question raising biological phenomena is seriously inadequate, incomplete.

The second error (the „error of affirmation") consists in pretending one sees, detects, observes something which in fact is nonexistent. In the history of the biological sciences some observers saw – supposedly with their own eyes – what nobody else ever saw before or after.

Medieval anatomists, for instance, described the nonexistent channel between spleen and stomach. In the seventeenth and eighteenth century followers of the preformation theory „saw" minute homunculi in human eggs (or in human spermatozoa). In our times many scientists, for instance, keep telling us how DNA shapes protein molecules, cell organelle, tissues, organs and even human behavior. From the empirical, molecular, biochemical point of view this complex, hierarchical, causal activity of the DNA polymer molecule is absolutely undetectable, both practically and theoretically, even within a single cell – just as the homunculus in the sperm remains undetectable until now. It is true, of course, that the enciphered messages found in the cellular DNA structure greatly facilitate selection of the proper sequence of the amino acids (the primary structure) of cellular proteins. Those messages, however, are not sufficient to determine properly the final, functional shape (tertiary structure) of even such a simple protein molecule as insulin.

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[1] Cfr. Lenartowicz P. SJ. 1996. *The body-mind dichotomy – a problem or artifact?* Forum Philosophicum, vol. 1, p. 9-42.

Summing up, essential and quite evident biological data are often rejected (because of the first error), and pseudo-explanations are accepted (because of the second error).

Our essay may be considered as an exercise in ostensive definition. Ostensive definition consists of an object to be observed and a set of linguistic indicators which guide the process of observation. If there is nothing to be seen, no indicator could help. If the indicators are misleading, the essential elements of the object may remain unregistered. Our main aim is to visualize some fundamental dynamic relations characteristic of living beings. We are not attempting to interpret, or to solve the questions that those phenomena do open. Such an interpretation would be too long, too complex and probably too difficult. We intend only to make some statements concerning „matter of fact”, meaning the description of some fundamental question provoking elements of biological phenomena.

In the first part we are going to give a sketchy picture of our object, and in the second we will reflect on some guidelines, mental indicators. In the third, the last one, we will venture to formulate some epistemological conclusions.

I. THE OBJECT

The object is an Australian bird, which looks like a fowl. Actually it is called jungle-fowl *(Megapodius freycinet)*. Common birds incubate their eggs with the heat of their own body – but not our bird. Who would believe that the bird collects branches to make a fire in order to warm its eggs? Nobody. However, the jungle-fowl is even more intelligent. It constructs and then operates the „fermentation mound” – which might be rightly labeled a „fermentation oven”.

Incubation in the Fermentation Oven

During four winter months the bird prepares a big heap of wet leaves and branches. The heap may be up to 5 meter high and some 10 meter broad. After a time the organic matter in the mound begins to ferment and produces quite amount of heat. Then the bird prepares channels in the mound. The channels are dug in the strictly determined order, following the gradual spreading of the fermentation wave which starts in the center of the mound. Every 2-3 days, the female lays her egg in the warm, newly build channel.

But that is just half of our story. During the incubation period the male constantly monitors the temperature in the single channels (there are usually twenty to thirty channels in a single mound). The male ventilates the channel if the temperature rises above 34 centigrade, or covers it with leaves or hot sand when the temperature falls towards 30 centigrade. The incubation of the whole set of eggs may take even 7 months, which means that the male is rather busy 11 months a year and has just one month of holidays. The hatched chicks are fully formed and desert their parents immediately after clutching.

If we now look at the schematic, crude representation of the temperature level in the bush of Australia (see Fig. 1A) we may easily notice that there is a rather obvious contrast between the constantly changing temperature of the surroundings and the rather narrow range of temperature necessary for the proper development of eggs. That difference might ruin the future of young jungle-fowls. Fortunately it is compensated almost perfectly by the activity of the vigilant father (see Fig. 1B)[2].

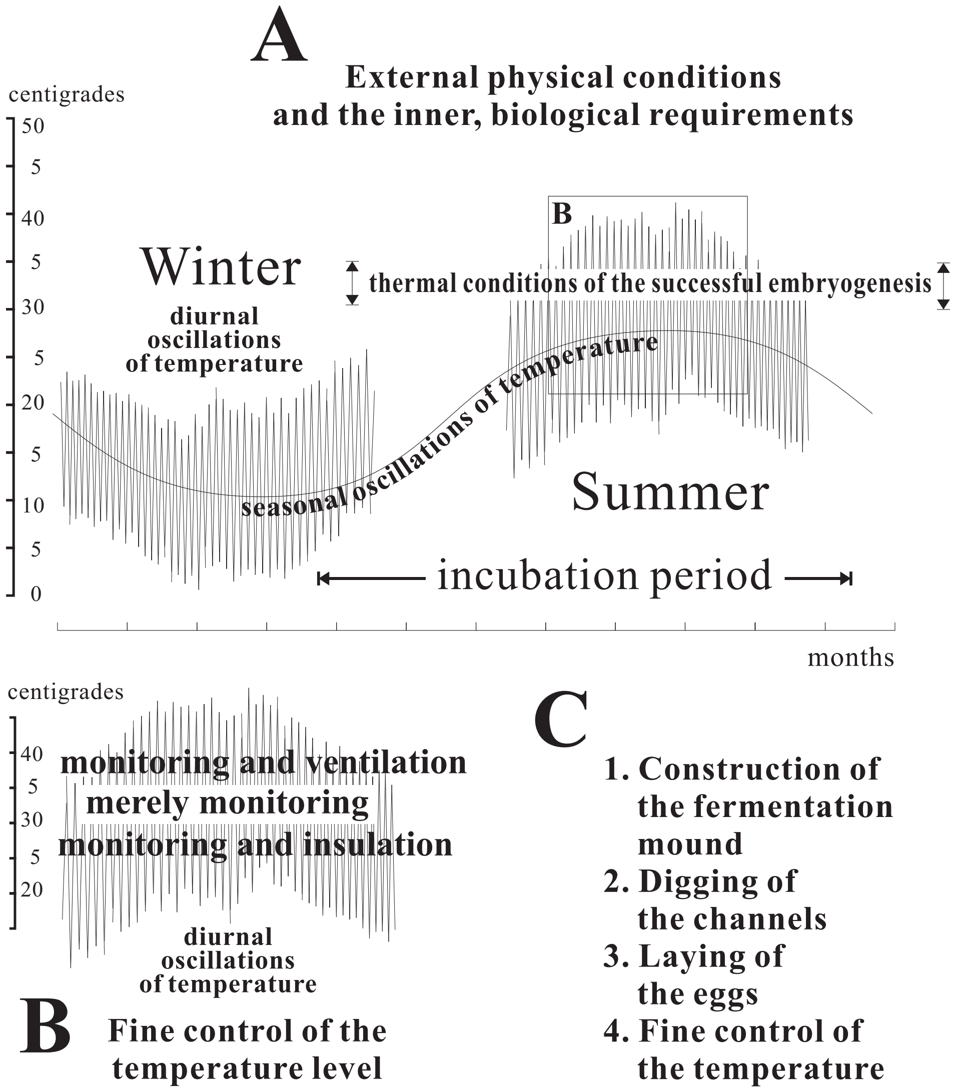

Fig. 1. Incubation control in the fermentation oven.

[2] In the laboratory conditions the bird was able to keep the temperature of the mound within the limits of a single centigrade. The bird achieved this in spite of the mischievous scientist who tried to trick it with the help of an electric heater hidden in the mound. See also Koszteyn J. and Lenartowicz P. SJ. 1997. *Biological adaptation: dependence or independence from environment?* Forum Philosophicum, vol. 2, 71-102.

Potential Forms of Incubation in Megapodius freycinet

The amazingly intelligent behavior of the bird is just a small part of its possible forms of activity. The Jungle-fowl manifests a whole range of different forms of incubatory behavior:

A. On the hot beaches of northern Australia the bird buries its eggs in the deep channels made in the sand. Then the bird leaves them there without any further supervision. The sand keeps its warmth during the night, and vicinity of the ocean diminishes diurnal fluctuations of the temperature. The eggs can develop safely without any further intervention from the parents.

B. Where the sea-shore is rocky, the bird fills the crevices of the warm rock with clay and leaves. Than the female lays its eggs there.

C. The Jungle-fowl has also discovered the Savo Island in the Solomon Archipelago. There, the warm volcanic steam filters through the vast areas of sand. Many birds of the Jungle-fowl species fly there to put their eggs in the sand and leave them there unprotected. The bird is obviously lazy.

D. Only in the bush area where the sun (or a volcano) does not provide enough of warmth, the Jungle fowl builds the fermentation ovens[3].

II. THE GUIDELINES – CONCEPTUAL INDICATORS

We have already mentioned the „indicators" which may guide our understanding of the object. Now we will try to present those guidelines and to demonstrate, with their help, the existence of some important inner relations within the dynamism of the bird. Here is the list of these guidelines:

Repetition	Physical causality
Selection	Correlation
Potential	Integration
Cognition	Motion

Repetition, selection and potentiality.

The first conceptual guideline is „selective repetition". In our „model" the different forms of the incubatory behavior are highly repetitive and selectively linked with specific kinds of surroundings.

The bird obviously selects among different forms of protective behavior. „Selection" denotes an abstract, mental idea. But this idea is molded in our mind from the repetitive elements of the objective, empirical data. In order to „select" one has to have a real choice. The choice, in our case, is made not between some external objects, but between the different, inner, complex behavioral patterns. Those patterns must have existed before selection was made, before – in a concrete surroundings – a particular „po-

[3] Cfr: Colias N.E., Colias E.C., 1984. *Nest building and bird behavior.* Princeton University Press; Cuisin M., 1989. *La vie secrète des bêtes. Les animaux des îles.* Hachette, Paris; Hill R., 1967. *Australian birds.* Nelson; Hansell M.H., 1984. *Animal architecture and building behaviour.* Longman, London and New York; Lack D., 1968. *Ecological adaptations for breeding in birds.* Methuen & Co LTD, London.

tential". Where there is no potential, no selection is possible.

In the case of megapodidae we have to do with a biological and behavioral potential. The elements of this potential exist in the distinct, modular complexes that seem to be of a whole.

Cognition

The next conceptual guideline is „cognition". The proper kind of behavior depends on the proper evaluation of both stable and temporary properties of the environment. Selection of a given strategy of incubation depends upon the cognition of the relatively *stable* properties of surroundings. Selection between ventilatory or insulator behavior depends on the cognition of the relatively *unstable*, transient quality of the surroundings.

An act of cognition may be selective, and the act of selection may be guided by an act of *cognition.* It does not mean, however, that the concept of *selection* could be replaced by the concept of *cognition* – or *vice versa* – without a serious damage to our sense of reality. Neither cognition, nor selection as such produce changes in the surroundings. They don't seem, therefore, reducible to the causal acts of an influence/effect type.

Motor activity

The third conceptual guideline is „motor activity". The birds actively modify the environment, digging holes or channels, preparing the mounds, collecting leaves to cover their eggs. This activity is selective and obviously guided by cognitive acts. *Motor activity* however cannot be reduced to the selective activity or to the cognitive activity. The term „motor" is used here in a very broad sense – any transfer of a physical body or energy means „motion".

Summing up we may state that in the life-cycle of a given, concrete bird living in a relatively stable surroundings three descriptive guidelines are of crucial importance.

1. Cognition

2. Selection 3. Motion

The above three abstract concepts make a sort of *indivisible set*. Motor activity of our birds is complex but selective, no doubt about it. The element of cognition is also hardly separable from the elements of selection and motion. Without cognition the capacity to act selectively would be hardly understandable. The very existence of megapode's brain and sense organs would look extravagant and ridiculous.

Now, in order to visualize a deeper layer of our object of study we have to explain the difference between the *causal relation* and the *correlation.*

Causal (physical) relation

A causal relation links an *influence* with its *effect.* For instance, the mound exemplifies *effect,* while the building behavior of the bird provides an example of *influence.*

Similarly the channel is an example of an *effect,* while the process of digging illustrates *influence.*

A physical causal relation embraces a concrete sort of material, an amount of concrete form of energy, a transfer of this energy called the „influence” resulting in the modification of the material.

The causal relations of bird's activity can be analyzed into a complex series of successive movements. The energy is spent in a selective way and the repetitive pattern of the effect is obtained.

Grasping the causal relation between the influences and the effects is absolutely necessary in the cognition of our object. But this concept is far from being *sufficient* to grasp of the whole reality of this object. Another, irreducible concept is necessary – namely that of *correlation.*

Correlation

What is the biological meaning of the word *correlation?* We cannot describe it with words[4]. We have to show it.

Let us have a look on the Figure 2. Do you see a certain „relationship” between the structure of the mound on the one hand and the structure of the channels? Is this „relationship” a sort of a mental illusion, or, to the contrary, this „relationship” does exits, independently of our cognitive acts?

Do you think this relationship can be identified with a causal, physical relation or „influence/effect”? Do you believe, for instance, that the structure of the mound influences the structure of a channel, or that the structure of the channel is an effect of the structure of the mound? Nonsense.

Do you see any causal (influence/effect) link between the structure of the leg, for instance, and the structure of the eye, or no link at all? Is there any link between the male's reproductive organs on one hand and the female's reproductive organs on the other? Is this a causal relation? We don't think so. We see an obvious link, but we cannot reduce it to the causal relation. Therefore we shall call it a *correlation*, because the actual meaning of the word in the common, ordinary language fits our purposes well.

The correlation may be detected a) in the context of the *functional dynamism* (e.g. the structure of a cylinder and the structure of the piston in the engine are correlated), or b) in the context of the *developmental dynamism* (e.g. the development of the bones and the development of the muscles are correlated).

The usual, and the most obvious way of detecting „correlation” consists in an attempt to separate the correlated structures. The dynamism of a piston is obviously res-

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[4] The mathematical term „correlation” is limited to the quantitative aspects of phenomena. It is, therefore, inadequate to convey the biologically meaningful aspect of reality. *„In correlation ... we are concerned largely whether two variables are interdependent or covary – that is, vary together. We do not express one as a function of the other. There is no distinction between independent and dependent variables. It may well be that of a pair of variables whose correlation is studied, one is the cause of the other, but we neither know nor assume this. A more typical (but not essential) assumption is that the two variables are both effects of a common cause. What we wish to estimate is the degree to which these variables vary together”* (Sokal R.R., Rohlf F.J., 1969. *Biometry. The principles and practice of statistics in biological research.* W.H. Freeman & Co., New York, p. 563).

tricted by the structure of the cylinder, the dynamism of the female's reproductive organ is impossible without the dynamism of the male's reproductive organ. One can „see" it, although this correlation can be detected on the condition that the observation field (both in space and in time) be broad enough.

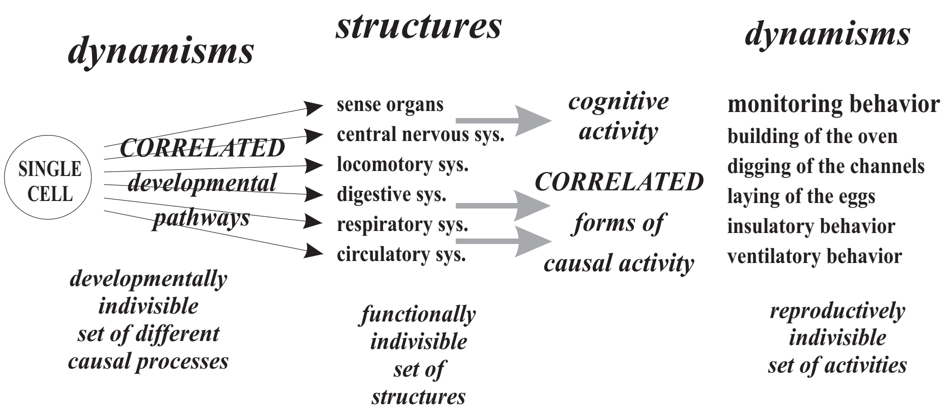

Fig. 2. Different kinds of correlations.

Integration

In order to obtain a new generation, the bird has to correlate many different forms of dynamism in a set which is actually *indivisible.* If any element of the set is missing, the end result cannot be reached. That is what *indivisibility* means. We call it „integration". In other words the biological integration refers to a complex set of elements which are physically necessary and sufficient to produce the end result.

That is a thoroughly *dynamic* concept of indivisibility. It does not apply to any single structure, or to any single, atomic event, but just to some complex processes which are repetitive, and operate close to the physically maximal economy of energy and material. Because of this economy the dynamism is exceedingly fragile, and this fragility is known in biology as the law *„all or none"*[5].

Indivisibility

The essence of the biological idea of integration is rooted in the idea of the indivisibility of the end result. Were the end result divisible, the idea of integration could be replaced by the much simpler and much more general idea of *proportion.* In the process of incubation the indivisibility of the end result means the alternative between a *dead* embryo or a *developing* embryo. The life of progeny depends on the indivisibility of the complex incubatory behavior of its parents. This behavior, therefore, can be called *integrated* in the described sense.

[5] Lenartowicz P. SJ, 1993. *Fundamental patterns of biochemical integration*. Ann. Fac. Philosophicae SJ, Cracoviae: 1993, 203-217.

III. SOME EPISTEMOLOGICAL REMARKS

What are the epistemological conditions of the proper biological method of description? What are the conditions of discovery of such empirical traits as correlation and integration?

The first condition is to recognize a dramatic chasm between the dead embryo and the living embryo. If one questions the dramatic chasm between the processes of decay and the processes of embryogenesis, all the rest of our story is pointless. Continuity of the species, of any single lineage depends on the survival of embryo.

The second condition is to realize how the narrowly determined limits of temperature parameters are crucial for the survival of embryo.

The third condition is to realize how different activities of the bird (cognition, selection, locomotion) cooperate in maintaining the proper and constant temperature of incubation (see Figure 1C). Any fault in this complex dynamism must lead to the death of the embryo. The survival of the system in some cases of mutilations was found to depend on a very accurate system of regeneration which only adds new dimension of complexity and poses new questions concerning the origins of biological integration.

The fourth condition is to realize that the set of the above mentioned activities is dependent on the integration (read indivisibility) of a determined set of body organs.

The fifth condition is to realize that the whole set of those body organs is produced within the egg. We call it *embryogenesis.*

The sixth condition is to realize that the complex set of the morphogenetic dynamisms within the egg is indivisible, i.e. integrated in reference to the chances of reproduction. Any imperfection in the morphogenetic dynamism jeopardize the chances of successful reproduction. The repetitivity of the life cycles in a lineage of generations is intrinsically dependent upon the integration of the morphogenetic dynamisms.

This is the end of our essay. We just tried to show what biological integration does mean. This concept – in our opinion – is not *theoretical* in the modern, subjective, or constructive sense of the word. It is a concept which can be visualized by a proper observatory approach. A fragmentary, purely analytical approach have to destroy any chance of detecting, and observing the inner, genuine, essential properties of the living bodies. We believe that in biology, contrary to many methodological and/or philosophical accounts, such descriptive concepts like „integration”, „whole”, „part”, „fragmentary” are just a corollary of the concept of „dynamic indivisibility” we tried to illustrate. The concept of the successive, repetitive „individual life cycles” (generation line) and the concept of the dynamic indivisibility („all or none” law) constitute the primary basis for the cognition of life. We also believe that those concepts are „prescientific”, i. e. they are shaped, almost spontaneously, during the early phase of human cognitive activity, probably during childhood. The prescientific and cruel experiments carried by children on the unfortunate insects or small animals constitute, therefore, the earliest phase of biological sciences. In those experiments the crucial question of the distinction between the structural divisibility and the dynamic indivisibility comes to surface.

A mental, conceptual attempt to break the fragile but evident indivisibility of living being into fragments turns our cognitive efforts from the contemplation of living objects towards the meditation on the properties of the dead, inanimate matter. Like children we are left with the dead remains, and like children we are unable to put life back into them.