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ON THE UNIQUENESS OF BIOLOGICAL RESEARCH*

ABSTRACT. The significance of the behavior of biological entities cannot be fully explained in terms of the physical and chemical processes upon which contemporary biological and medical research depends. The characteristic proper of biological entities is that they are systems marked by 'inwardness', that is, a capacity to interpret meanings in order to reach goals. The significance of this characteristic is given in examples from the author's morphological research.

Key Words: biological research, inwardness, organism

Modern biological research is so diverse, with so many different goals and methods that it compels close examination. Much of the development of biological research and of insight into the general significance of the various ways of conducting research depends on a deeper understanding of this diversity.

The work of the geneticist engaged in research on the hereditary properties of the cell-nucleus is different from that of the neurologist who investigates the structures of the central nervous system. The physiologist who tries to track down a definite enzyme effect in a gland has a different goal from that of an ethologist who investigates the social behavior of a school of fish or the relation of blossoms to pollinating insects. A considerable distance exists between the work of a paleontologist and that of an embryologist who experiments on a Triton embryo. How long did it take until the biological research of J. von Uexkuell achieved recognition as a scientific method? So different are these methods that at times people have tried to separate obsolete old methods from modern ones, or to differentiate exact methods from merely descriptively ones. Nevertheless, the study of life is a task that one will certainly conceive in a unitary fashion. Furthermore, the

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interaction with colleagues is necessary for every researcher; the isolation of specific research work is dangerous. Both the study of chromosomes and neurology encounter similar basic questions of localization and come upon the same borderline situations of understanding. The psychologist, like the ethologist, experiences again and again the necessity of looking for the reference system that can give meaning to his own results. Ultimately, the paleontologist, the embryologist, and the geneticist all work on the same basic problem of the homology of components in a common plan.

How can one survey this complexity? Into what greater coherence can the results of these different modes of work be meaningfully organized? This is the question the following analysis attempts to answer.

Our attempt is determined by a basic concept of the organism, a cardinal point of which shall be emphasized immediately. We want to stress a fact which is completely disregarded by many, and which has been moved as far as possible to a peripheral position by others who view it as an inconvenience: We refer to the fact that organisms, as relatively autonomous active systems, possess the quality of "inwardness", and that the intensity of this "inwardness", especially in animals, increases with the increasing level of organization. We mean by this term "inwardness" that characteristic of life which we know from our conscious experience most intensely, and which can be measured not by the dimensions of space, but by those dimensions that are "mechanisms for the articulation of meaning" (*Bedeutungseinrichtungen*), and that in human beings are represented allegorically by language. Biological research that studies inwardness has often been neglected on the ground that it opens the door to anthropomorphism, because we are most familiar with inwardness in ourselves.

The inclination to interpret the phenomena of life on the basis of the experience of human feelings has been resisted for some time, because it allegedly endangers research. This understandable resistance has, however, pushed a central fact of life to the periphery of observation, namely, the fact of inwardness, that living beings are autonomously acting beings.

Indeed, given the restrictions of research to structure, development, metabolism, and reproduction, study was concentrated upon more easily comprehensible phenomena of life, and knowledge was thereby enlarged tremendously. This increase in

knowledge, however, has been at the price of a corresponding impoverishment of our conception of life. It has been sacrificed to a false notion of objectivity, which arose when one removed from the "object" of research on life the particularly important quality of "subjectivity", and thought that life would become thereby more scientifically comprehensible and could be explored more exactly. All that one achieved, however, is a deceptive approximation to the characteristics of physical research objects, because one had completely failed to observe that this approximation could not be understood as the self-evident goal of all biological research, and because of the generally unnoticed fact that one has ignored inwardness.

For some time, however, a change has been taking place, an awareness about the specificity of biological research. As a consequence, the central significance of inwardness has also been recognized again. If we acknowledge the importance that is attributed today to behavioral research and to ethology, we are clearly confronted by a new orientation. However, we should also note that this change manifests itself in that field of research that once was programmatically named "developmental mechanics", both in the modification of the name to "developmental physiology", and in the changing perception of the leading researchers as they focus on their object of research. To cite Hans Spemann:

However, I think I still owe the reader an explanation. Again and again, expressions were used that denote not physical but physiological analogies. That this has happened is meant to be more than a poetic picture. What is meant is this: the topical reaction of the segment of a zygote, endowed with the most different potencies in an embryonic "field", its behavior in a distinctive "context", are not the usual, simple or complicated chemical reactions. Rather, these developmental processes ... in their coherence have no greater similarity with anything we know than with those vital processes that we know most intimately, the psychological. Aside from just the philosophical consequences, in the interest of progress of concrete exact knowledge we should not abandon the advantage of our position between the two worlds, i.e., the mechanical and the subjective. With my experiments I took, I believe, a step forward on the road to this lofty goal (Spemann, 1936).

The significance of this change is, to be sure, by no means fully recognized, and I consider it an urgent task to emphasize it and to facilitate its breakthrough. We should put at the center of research

into living organisms the peculiarity that they are always centers of activity, that organisms relate actively to their environment, and that this centrality presents that specific mode of being that we know maximally from our own experience and to which we give the general term "inwardness".

As just said, we know this "inwardness" best from ourselves. A statement about the specificity of being alive becomes ever more inadequate and more difficult as the ontological distance separating living beings in general from human beings becomes greater. Today we have gradually come to realize that we are not justified in restricting our attention to virus material or a bacterium, i.e., the one-cell organism, because the results of research into these forms of life are too elementary character to give us the phenomena of life, in general in an easily accessible form.

Our biological research, based on the totality of our perceptions and experiences, shows that inwardness discloses itself in all of the organism's manifestations, that there are levels of intensity of inwardness, and that these levels can be recognized by us in the characteristics of their manifestation. This view demands special caution on two counts: on the one hand, we have have to examine carefully what in way the wealth of our own inwardness also belongs to other levels of life; on the other hand, the poverty of manifestations of inwardness in that counterpart of us that we call the "lower" forms of life must not entice us too easily into a transition to the inanimate world, where the uniqueness of life shows itself even less clearly.

As always, change of form caused by growth and metabolism, development, reproduction, and regulation will be important criteria for testing life's processes. But the study of these manifestations must be embedded within a broader concept of the organism. This broader concept widens the perspective to multifaceted research of living beings as centers of inwardness. We have drawn above at least some outlines of the concept of the organism with which the intentions of the research biologist are concerned. Now let us elicit the particular methods of research.

In what way do the questions of biologists refer to the reality of the object that they are required to investigate in its wholeness, the sum of the structures in and through which it lives? In trying to give an answer we shall see that the questions of biological research are more diverse than we usually think. The relative clarity of widely used scientific research methods, viz., experimen-

tation and comparison, has frequently supported and promoted the error that a similar agreement exists in the kinds of questions. Let me try to point out more precisely the actual contrasts that are an essential premise for an overall view of the wide field of biology. I shall try to achieve this through a metaphor which is meant to make clear our various attitudes toward living processes. A metaphor can help us only if it originates from a field which is more comprehensible than the field that we want to illuminate – in addition, the metaphor must encompass the entire complex which engages our attention, that is to say, not only the living object we want to comprehend, but also the biologists who strive to comprehend it.

Our metaphor is the performance of a play. This metaphor is complicated and dynamic; it is valid for many different kinds of performances; it thus can reproduce a wealth of ways of life even in a limited form. Its most significant use, however, it provides through its twofold aspect: the complementarity of the activity behind the stage and the activity on the stage, which creates the two different situations in terms of which a research worker can formulate his questions. This metaphor of the performance of a play shall be a means to see more clearly the struggle for an adequate view of what we mean by life. Such an attempt owes much to similar previous experiments which through the stage metaphor try to elucidate some feature of life. The metaphor has a long and rich history that cannot be described here. In this presentation, however, it has a particular meaning which is different from the goal of biologists who likewise employ the metaphor of the theater of life.

The observer behind the stage sees an unfolding of forces in a workshop which is absolutely necessary for the success of the performance. Here we observe the factors which regulate the sequence of the scenes, guide the single actor, and change the scenery. We see how the machines work that produce the sound of the rain, the thunder, and the lightning, and we recognize many of the activities that determine the details and the whole of the play. As an observer of these happenings behind the stage I can make this "look behind the scenes" the exclusive center of my interest. I can focus intensely on acquiring the knowledge that is necessary for such work. I may also study the historical development of the behind-the-scene technicalities and present them so vividly and arrestingly that they seem to be the most important

part, the solely important element of the performance.

If, on the other hand, I remain in front of the curtain, then I know the activities going on behind the stage, but I also know that I can fully comprehend the play only by completely ignoring these activities. Only by completely forgetting them will I be fully captivated by the play.

Standing in front of the stage, I can participate in the play. I can be moved by it, or I can view it cognitively, analyze it scientifically. But even in the latter case I must maintain the standpoint of the observer in front of the stage if I really want to do justice to the play's content, if I want to explore it in detail.

Still another situation may be considered: We are in an entirely strange country with different customs and with a language we cannot understand. There too they perform plays. We go into the auditorium and see and hear the foreign play. Some parts we understand, others we do not, and yet our attempt to understand the play, as well as our abandonment of understanding, are always made in the certitude that a meaningful play is performed.

It is time to return to our task of exploring the phenomena of life and of testing the comparative value of our metaphor. We want, however, to apply the metaphor cautiously, and to expect from it nothing more than a heuristic clarification.

Perhaps it is good to remind ourselves that our metaphor contains a simplification. We speak of two aspects: *on* and *behind* the stage. Reality provides still other standpoints. The poet, for instance, stands in relation to the performance in a superior place, one which includes both aspects. In a different way the same holds true for the director. It is not difficult, we think, to see why in the scientific investigation of life we usually restrict ourselves to the double aspect: *on* and *behind* the stage.

The accent, in other words, lies always on emphasizing the dual character of the entire situation of a play's performance. The emphasis is thereby on the necessity of at least a twofold way of thinking and a twofold type of research. We may see the play naively, or explore it scientifically: the twofold aspect is always present. The observer will always be able to evaluate what he sees in a broader context if he is very clear about the distinctive feature of his own standpoint.

The situation of biological research confronted with its object – life – presents the same twofold aspect. It also necessitates viewing and exploring biology from at least two standpoints.

With the awareness of the twofold aspect, many disputes concerning problems of rank and of differences of the "scientific character" of various biological research methods become unnecessary. Only the sum of the several possible research approaches can provide a scientific description of a biological research object at any given time.

Today research that corresponds to the "back stage" occupies the most space, one may say, and represents the prevailing efforts. Therefore, when I introduced our metaphor, I spoke first of what happens behind the stage. It is a matter of describing the organisms, dissecting them, and examining their parts in terms of their material and functional characteristics. The greater proportion of morphological, physiological, ontogenetic research, and genetics is occupied with this task. These modes of research take priority for practical research, because the practice of biological technology must rely especially (though not exclusively) on this type of research. He who wants to intervene with the processes of nature must control them, whether or not the final goal of his intervention is positive welfare or destructive. Thus, the grand symbiosis of medicine and biology prefers primarily this standpoint; the powerful biological technology that emerged from research in pharmacological chemistry needed first of all to promote this type of research. This type of work, this invasion into the world behind the stage of living processes does not need a detailed explanation in order to emphasize and justify its importance; for it is just this mode of biology which dominates the field today, and which will always be a frequent variant, quantitatively probably the decisive variant, of biological research. The biologist must not be astonished that this mode of research that goes behind the stage needs to be preferred wherever control plays a role; but in judging scientific modes of research, this point must never be forgotten. However, it is precisely the undisputed significance of this type of research that has led to a grave one-sidedness: to the attitude that this mode of biological research is biology proper, biology as such. Consequently, a concept of the organism was developed that was not only too narrow – this insight has been noticed frequently – but also, because of its standpoint, completely one-sided in its conception of the living being. The fight against this narrowness and one-sidedness was futile, because one did not realize that the problem is ultimately one of the human standpoint, an anthropological problem. One

did not see that the results obtained from this standpoint could be entirely "correct"; but that from quite another perspective, the results could be entirely irrelevant, and in all their "correctness" entirely insignificant.

Thus a model emerged that the organism was merely a "carrier" of functions, the notion that the activities of metabolism, of regulation, and of reproduction existed merely for their own sake and had simply subsumed the "carrier" that made possible the execution of these activities. Phenomena that could not find a direct explanation through such an analysis were explained as being indirectly related to these functions through some internal dependence.

The attitude toward animal hide patterns illustrates this orientation. To "explain" a pattern, as for instance, the striping of a zebra, one tried to account for the pattern as a necessary sequence of certain rhythmically spread states in the embryonic skin. These skin-states were attributed to lawful causes and necessities. The final pattern was an unimportant and senseless sequela. Characteristics which we explain morphologically were, as the botanist Goebel once held, those features of an organism that could not yet be explained physiologically.

I must leave it to those more qualified to test to what extent a variant of the common idea may have participated in this peculiar *misinformation* of the living *Gestalten*: that the essence of a thing should always be sought as something concealed in its interior, in other words, as hidden in it. The appearance is thus reduced to something of a "fraud"; the interior is the essential. The microscopic is more essential than the macroscopic; the atomic more essential than the microscopic. This kind of thinking should some day be recognized by biologists as dangerous for biological research, if they are to avoid in the future some gross misinterpretations. The elevation of the physico-chemical sciences to the natural sciences par excellence is also partly responsible for the interpretation of the living organism just mentioned. Due to the well-founded high esteem of the physical-chemical methods, one completely overlooks the fact that this type of research does not in dealing with its object in any way recognize the dual aspect of the two standpoints. It achieves the desired analysis of its subject matter by approaching it from only a single standpoint.

The image on which we base our attempt to comprehend the phenomenon of organisms can simultaneously show us a solution

to several misunderstandings. It will also demonstrate the complete inadequacy of the above-outlined interpretation of an organism as merely that of a carrier of functions of survival. For, by being aware in our research of our standpoint behind the stage, we are immediately forced in principle to require simultaneously research on the stage, and thus we assign the same type of scientific tools to both of these modes of research. Our comparison immediately reveals that by observing from the front of the stage, we experience a totally different aspect of the phenomenon of living than previously experienced when we observed the aspect behind the stage.

The dual aspect, the decisive point in our metaphor, reveals itself at each examination of a living process, whether I choose a narrower or larger part to examine.

Turning to the metabolic functions in plants or animals, it is clear that the analysis of substances may be done by the methods of the chemist, and that of organs by the methods of the morphologist. A more profound examination will succeed in locating special tools as, for instance, the formation and effect of ferments. But all these metabolic properties only lead to a truly biological understanding when I relate the results of this examination behind the stage to a play that is actually performed – in this case it is called “maintenance of the organism”, or “development”, or something similar.

In the physiological examination of organ functions, the whole of which such functions are a part is usually so striking and visible that, in general, one has always recognized the role of such functions in a play. The situation is quite different if one moves beyond the area of the elementary maintenance functions, and if the point is to recognize the more individual modes of functions and of interrelationships in the appearance of the organism. Here the play that is performed is not immediately self-evident. It must first be understood as such; only this insight, often not easily obtained, leads to an association of previously not-understood properties of organisms with more than individual interrelationships.

As an example, consider a red, wild carnation which blossoms on the stony ground on a sunny slope. The scientist who examines this red carnation, finds, let us say, a pigment of the glycoïd group, an anthozian. He is also able to discover the conditions under which such a red hue appears in the interstitial spaces of

the petals; likewise with respect to its connection with sugar metabolism, assimilation, the influence of light, warm temperature, etc. He can also examine in much detail the basic plan of the point of vegetation and thus elucidate for us the formation of such a blossom. Intense morphogenetic, biochemical studies will perhaps one day lead to an extensive knowledge of the hereditary factors which help to form the blossoms, and to a comprehensive scientific presentation which will offer the impression of an exhaustive completeness, especially if we focus exclusively upon the isolated blossom merely as a part of the plant.

But what happens if I discover the interplay of the blossom with a butterfly and begin to consider that aspect? Then I soon find a new wealth of facts about the blossom as well as about the structure of the butterfly, all of which can only be understood in a context that is not at all grasped by the previously discussed investigation of the plant. Note that this new mode of examination is not just an expansion of the scientific picture that has already been supplied. Rather, it means taking an entirely new standpoint.

Let us first of all notice that from this new standpoint all previously experienced facts remain as they were, and are true; however, they are no longer of focal importance. It is, for instance, entirely irrelevant what chemical substance constitutes the red of the carnation, and when in its metabolism this blossom appears. Relevant now is the fact that the blossom is red, and that this red – the emergence of which is unimportant – acts to provide a particular stimulus to the eye of a higher animal structure, e.g., an insect. The same fact – the red blossom – appears as an element of a meaningful connection in another system, quite different from the previously described one: a system in which perception plays a role, be it the perception of a seeing organism in relation to another seeing organism, or the perception of a seeing organism (insect) in relation to a non-seeing one, as in the case of the red blossom.

For the moment, the chemical nature of the red substance is unimportant. What is important is the fact that a luminosity against a background appears as a figure, a *Gestalt*. This red thereby acquires a certain kind of kinship with the red of other flowers, though perhaps chemically entirely different, e.g., the red poppy, the red of fruits, the peculiar lipochrome-red of the pharyngeal color of open-mouthed songbirds, even the red of flags and traffic signals. It is specific for all these figures that they affect, in a

wide system, a living eye as a *Gestalt* against a background; that in their shape and localization several essential characteristics can be demonstrated, all structured and coordinated to emphasize a precise outline, a distinct contrast of a figure against a background, and clear visibility of their positions.

The relative ease with which such *Gestalten* are recognized in social life contains a danger that these wholes may be viewed as manifesting only "the significance" of the structures, and that ultimately the appearance of the organism is again construed as a collection of stimuli. While in the past the external form was judged to be a more or less irrelevant "envelope" hiding the "essential" structures (e.g., the internal organs), today the danger is that it will be viewed as merely a collection of signals, as, a mere carrier, so to speak, of traffic signs. Such an interpretation has been willingly acknowledged by research workers, the more so since such "roles" are easily understood as useful functions and thereby comprehensible to everyday thought.

However, if we seriously contemplate the idea of the twofold modes of research on living processes, we shall have to entertain the possibility that here, too, many "plays" that we watch are performed without our full comprehension. Indeed, we should accept this assumption as much more probable than its opposite, namely, that we had completely understood the living organism in its significance. Thus, along with our intuition about the meaning of unintelligible plays, our notion of the horizon of understanding also goes beyond the more familiar notion of utilitarian plays and roles. We strive to learn the languages in which the not-understood plays are written and performed.

However, with this view of an organism as a not-understood "play", have we not crossed that borderline where a scientific investigation ends and speculation begins? We are of a different opinion: research into the meaning, and scientific inquiry into the "roles", of *Gestalten* is possible insofar as a distinct scientific reference system can be constructed in which meaning plays a major role. Keeping with our metaphor: as long as I see the possibility of learning the foreign language of and gestures in the play, the possibility remains of one day understanding the unintelligible play I have seen.

To determine as much as possible the scientific reference systems in which the external appearance of an organism has

meaning and significance is a new task, but in an old field of research: morphology. Decoding the language of living *Gestalten* has hitherto been attempted in very diverse, but only incipient, stages of morphological research. Even if the research behind the stage allows us, because of its powerful practical results, to forget that the processes stand in the service of an actual play, the insight into the necessity for more profound *Gestalt* research leads again and again to attempts to learn the languages of the external appearances of living organisms.

May I point out a few insights that in recent times have become more clear through morphological research?

The determination of the degree of cerebralization (Portmann, 1948) through intracerebral indices allows for the first time determination of the relative mass of higher centers in relation to the mass of the elementary parts of the cerebrum. Criteria thereby result which allow an arrangement of the brain centers in groups that are undoubtedly morphologically related. Applied cautiously, this arrangement can serve as a reference system in which the external appearances can be arranged to correspond with the characteristics of other senses, such as scents or tone *Gestalten*. I have arranged such characteristics in vertebrates, and have called attention to the regular relations which exist between rank and appearance. It is apparent that the lower forms carry patterns in which the location of conspicuous markings appears to be quite arbitrary, while in warm-blooded animals the head or the reproductive pole, and often both together, is the carrier of formal accents. It is also apparent that in ruminants, in other words in a group of closer kinship, a separation of the external sexual characteristics takes place with increasing cerebralization. The prominent eyeteeth disappear and the components of the forehead dominate. The disputed phenomenon of the descensus of the gonads in male mammals, the descensus of the testicles, acquires in the ranked reference system a meaningful interpretation: it becomes another part of the ornamental characteristics of the anal pole. The proof of the connection of non-utilitarian phenomena with facts of organizational rank provides us with the first hint of a meaning of *Gestalt* characteristics of organisms that does not remain within the reference system of the elementary survival function of an individual, but plays its role in a totally different reference system, namely, in that of organizational rank.

I have characterized the particular significance of the characteris-

tics of external appearances which can be shown to be related to organizational rank as the "display value of the phenomenon" (Portmann, 1948). The characteristics of *Gestalt* possess this specific display value beyond all purely survival functions. F.J.J. Buytendijk (1928) pointed to the same aspect of the phenomena of living beings when he spoke of the "demonstrative value of being" of living forms (Buytendijk, 1928). Similar facts are emphatically underscored by H. Peters (1928), who separates a superposed "whole of form" from a functional whole (Peters, 1948). The attempt of R. Woltereck (1940) also must be mentioned in this connection; he speaks of an expression of ideas of organic form free of purpose and calls them "artistic of formation" (*ibid.*). I mention these endeavors, because they originated with experienced biologists who have experimentally investigated vast areas of animal life, and because their conclusions serve as important hints of a richer concept of organism.

Display value also belongs to organs that are associated with elementary functions of survival, especially organs for social information and the expression of mood. Their display value can be demonstrated. Such organs reveal forms that exceed the optimal functional value of the elementary survival function. If the mere presence of an organ can be associated with an elementary task, still some feature of its specific being becomes meaningful only when one considers its display function. The reference system that is given through the determination of organizational rank allows one to identify some phenomena as belonging to a more encompassing living order, and elucidates properties that elude the usual functional interpretation, which is viewed only one-sidedly in such relation. One example suffices: the external ear of mammals is primarily an organ of the auditory system. It remains in this role before anything else, for all simple, rat-like "lower" mammals; in others, it serves for temperature regulation. But with higher cerebralization, the external ear also plays the role of an organ for social information: the various positions of external ears function as signs of changes of mood in beasts of prey and hoofed animals.

However, beyond these roles these structures, through enlargement, hairiness, coloration, and position may be associated with principles the particularity of which do not belong to any of the mentioned functions. In these specific articulations of form, the level and the uniqueness of the animal species in question

manifests itself with unmistakable precision. We call this fact the "display value" of an external part of the organism.

The examination of the display value leads via the structures providing survival value – whose considerable development in external appearance has already been emphasized – to external appearances that belong to an order which transcends every survival function. It is possible to establish this reference with scientific rigor, even if the precision of measurement cannot readily be achieved. This possibility of scientific rigor opens an ultimate horizon of understanding within the framework of scientific biological research. By demonstrating the connection between rank and display value, it calls attention to the very essential biological phenomenon of inwardness. It does so by focusing on an aspect from which disclosure of inwardness was least expected: (external) appearance.

Our attempt to indicate the standpoint of biological research does not aim to generate a new biological taxonomy. Rather, our aim is to view in as encompassing a way as possible the particular beings which organisms are. Then everything that can be disclosed scientifically can find its proper place in a suitably far and broad horizon. Our picture of social life serves this broad view.

Living processes reveal their dual aspect, however, in every instance. On the one hand, the dual aspect requires the investigation of service structures and functions, and on the other, it demands at the same time that we understand the superposed whole that uses these structures and functions.

The two possibilities of investigation each require a specific method. Investigating the serving structures, we are able to use to a great extent the methods of the physicist and chemist. Nobody will fail to recognize the relationship of physics to biophysics, or of chemistry to biochemistry; but in using these methods we still must pay careful attention to the specific characteristic of the phenomenon of the living. The comprehension of the superposed realities which utilize the structures and functions discovered by these methods demands quite different and specific methods in order to answer the questions posed here.

In our survey the accent was placed very intentionally on the second standpoint, the aspect which concerns the front of the stage, the exploration of that living reality which utilizes the backstage physico-chemical effects. I find this front-stage emphasis urgent, because it is hardly necessary today to emphasize

the powerful backstage research methods to which biotechnology owes its great potential.

Our emphasis of the dual aspect of biological work is intended to counter an impoverished, one-sided comprehension of the phenomenon of life, and thus to provide a richer, broader one. We are principally interested in exploring the intuitive idea that the external appearance of organisms has a significance that transcends by far its mere survival function, and about which we can learn something significant through *biological* research. A great number of our contemporaries must first be made to understand that it is not the function of living organisms to be merely complicated metabolic apparatuses, but that metabolic organization is the manifestation of something more important: namely, the enigmatic reality before us, whose meaning we try to understand as much as we possibly can, which is the essence of biological research.

The scientific attempt to uncover the meaningfulness of the external appearances of living beings presupposes a model of the boundaries of the human understanding that allows for scientific assertions about the external appearance of living beings may possibly play. That which may be said scientifically about the organism at any given time can only be found in such a broad horizon of understanding. But if a reference system appears in which the meaning of a living *Gestalt* can be recognized, then science must place this meaning in question and investigate it with the appropriate means.

The concern to discover a scientific reference system is the most important task of biological research that has as its goal an all-encompassing view of what we generally call *being alive*. The subject matter of biological research that becomes visible by emphasizing the display value of organic *Gestalten* becomes legitimate as a scientific field of inquiry by arranging the facts to be tested according to a hierarchically reference system. This system must be made as precise as possible by determining degrees of *cerebralization* through metrical means. Nobody now knows how far biological research of this type will extend the horizon for fully understanding living *Gestalten*, but provided that what actually can be said at a given time will be said, the old saying also holds for biological research: One should think big about the object of one's research.

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