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Biologiske Meddelelser. **VII**, 2.

ON SOME BIOLOGICAL PRINCIPLES

BY

C. G. JOH. PETERSEN

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HOVEDKOMMISSIONÆR: ANDR. FRED. HØST & SØN, KGL. HOF-BOGHANDEL
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A. Introduction.

The conception of biology can be limited in different ways; it is here for our present purpose taken in its wider sense, i. e. including all phenomena, both material and psychical, concerning living organisms, plants as well as animals and human beings. Biology thus taken in its widest sense includes a great number of sciences which have gradually arisen. To examine as far as possible the kind and quality of the principles with which these sciences work is the chief aim of this essay.

Biologists as well as philosophers have written any amount about these questions, and one would be overwhelmed by the literature if one tried to grasp or master it in its whole extent. It appears hopeless to make an effort in this direction, but recently so many excellent accounts have been produced, that it is possible to keep to some of them, the more so that certain problems have one after another been elucidated, so that it is not necessary to go too far back in the literature.

In my efforts to elucidate the principles that should be used as a basis for biology considered as a natural science, I have especially kept to biological works. Partly because it is natural to accept the authority of some of the leaders of biology in their own line and partly because as a rule most philosophical papers are too abstruse for me; an exception is however made of part of the works

of I. Kant and H. Høffding. As a natural point of departure for the investigation I shall start by mentioning the attitude of biology towards the common sense view of living things.

B. Principles.

a. Biology and Psychical Qualities.

It is natural as well for the biologist as for laymen who are well acquainted with animals and plants, to consider them in a way analogous to our common sense view of ourselves, and especially it is common to credit many organisms with psychical qualities, — just as in every-day life, interpreting our fellow-men's activity and behaviour, we are inclined to believe that their activity is controlled by consciousness akin to our own. It is thus an every-day and natural view, that the activity of other living organisms is also controlled by consciousness, and the more the behaviour of these organisms appears to be like our own, the more we are inclined to ascribe to them consciousness akin to our own. This simple every-day point of view has also found certain advocates within biology and represents a special direction, psychobiology.

Experience from other sciences shows, that it is not always scientifically justifiable, or at least not always profitable, to take the every-day point of view as a base. Sometimes this view cannot hold its own against closer investigations, and sometimes it has proved incompatible with the methods that must be used by science in order to be certain of following sufficiently established lines.

One of the best brains in biological science was probably that of T. H. Huxley, who lived in the time of Darwin and was one of his best champions. In many works

he has expressed himself with perspicuity on the position of biology, e. g. towards psychobiology. I may especially mention his book on The Crayfish and his Lay Sermons, and I shall try to outline his attitude towards psychobiology and other questions.

If we have a living crayfish in an aquarium, says Huxley, and we put our hand quickly down into the aquarium, the crayfish will flap its tail and turn away from the hand, but if we gently lower a piece of meat into the aquarium, the crayfish will sooner or later draw near and eat the meat.

If we ask why the crayfish behaves thus, everybody will be ready with an answer. In the first case the crayfish is made aware of a danger, and turns away. In the second case it knows that food is good and that is why it approaches it and eats it. Nothing seems plainer and more satisfactory than these answers, until we try to understand clearly what they signify; then the satisfactory character of the answers disappears. For example, what do we mean by saying that the crayfish is "aware of a danger", or that it knows "that food is good"? We cannot think that the crayfish says to itself: "this is dangerous" or "this is good", for it has no language and thus it is not possible that it can draw a logical conclusion, as a human being would do on such an occasion. No, its actions must rather be compared to those of a little child, a child who cannot speak yet and who unconsciously undertakes many "purposive" actions without knowing it, which by the by we also do as grown-ups in spite of our consciousness.

It is thus an open question whether the crayfish has consciousness or not, and it is furthermore a question that

cannot be solved; the only possible way in which to solve it would be to make ourselves into crayfishes. Even if a crayfish has consciousness, this fact would not account for its actions, but only show that these are accompanied by similar phenomena of consciousness as our own in similar circumstances.

No, says Huxley, we had better leave the consciousness of the crayfish alone and turn towards a more profitable investigation, namely that of examining what actions the crayfish will go through when certain psysical phenomena take place in its proximity; in other words we must consider the crayfish as an automaton i. e. a machine, a mechanism of which the inner construction determines certain movements, when affected by special outer occurrences.

As here made clear, Huxley absolutely dismisses from natural science everything psychical, and this is an abstraction which has proved immensely useful as a working hypothesis. As far as possible we must try in natural science to account for everything by the qualities of atoms and molecules, and he sees no reason to depart from this point of view when dealing with living beings. However, he is the first to acknowledge that "the laws of nature" established by us are not the causes of the order of nature, but only our way of giving expression to what we have grasped of this order of nature; our knowledge is not absolute, but only relative and limited.

The mechanistic method in natural science thus does not warrant the supposition that we can thereby solve all the important questions of life, and that mechanism is under every condition the right point of view; no, that would be as if a mathematician should consider all the x's and y's used by him when solving his problems as

real things, and still worse, because, while this mistake of the mathematician would have no pratical consequence, the errors of a thoroughgoing materialism would paralyse the power of mind and wreck the beauty of life. On the contrary we should be convinced that we have the capability of studying the order of nature to an almost unlimited degree and that our will-power has some influence on the course of events. The truth of these two tenets can be proved by experience as often as we wish it, says Huxley; they are therefore based upon the strongest foundation any tenet can have, and they form some of our highest truths.

The study of mental phenomena belongs to a different science, psychology, while biology proper, according to Huxley, deals with material events only. This natural-scientific biological method is therefore a limited method.

This limitation of biology has in many ways proved a great boon to it, and to this day is followed, in the main, by physiology; here it need only be mentioned that a supplement is required in spite of all, about which more will be said later. But I have thought that the plainly worded demonstration, by Huxley, of the impossibility of introducing psychology into biology proper is not superfluous when considering the attitude of so many biologists towards the question, and particularly that his account of it is a useful antidote to the psychobiological tendencies in biology, which have, also recently, been cultivated.

It is interesting to note the views of a present-day English physiologist, E. H. STARLING, on these questions. In Principles of Human Physiology (1926 p. 8) we read, "physiology is concerned not with the study of consciousness but with

the conceptions in consciousness of the phenomena presented by living beings. Consciousness in fact we know only in ourselves. From the actions of other living beings similarly organised we infer in them the existence of a similar consciousness. Again from the fact that the reactions of higher mammals are evidently determined, not by immediate impressions but largely by stored-up impressions of past stimuli, we credit them also with a certain but lower degree of consciousness. As we descend the scale of animal life, evidence of the existence of consciousness, as we know it, rapidly diminishes and finally disappears, though it is impossible to draw a sharp line between those animals which possess consciousness and those in which it is absent. That it is a necessary accompaniment of life is certainly not the case".

Thus Starling thinks, almost like Huxley, that physiology has nothing to do with psychical attributes, but only with visible phenomena that may be made the subject of observation by others.

Not only methodological reasons, like those enumerated by Huxley among others, speak for the exclusion of the psychical element, but also actual observation. When we discover within ourselves, that so much happens without the co-operation of our consciousness, our psyche — among other things the maintenance of, as far as possible, normal conditions by our whole organism, most of our development from ovum to adult (ontogeny) etc. etc. with so much apparent purpose — it is natural to suppose that the same processes also take place without the co-operation of consciousness in the lower world of animals, i. e. by mere instinct, purely reflexively, and that everything happens in the same way where the lower organisms are concerned.

How far down in the scale of organisms consciousness or forerunners of consciousness may be found, it is impossible to know; but consciousness, in the sense in which the word is used when referring to man, surely does not exist in all living things. There is no foundation whatever for crediting all the lower organisms with a consciousness having any influence on their actions, such as we in certain cases naturally think that our actions are influenced by our consciousness. Far down in the scale of organisms only life is found. Life there includes elements perhaps from which consciousness arises higher up in the scale, but from all this unknown field real biology turns away. This is the point of view of biology. It is thus impossible for biology to solve the highest problems of existence. Biology is not religion, though these two conceptions have often been confused by the public.

A similar point of view is powerfully set forth by F. Hempelmann (Tierpsychologie 1926). He is obviously much influenced by the works of Uexküll (see below) and strongly emphasizes that the animal psyche, if at all existent, is never objectively accessible to us; we must confine our efforts to the examination of such exterior impressions as may — according to the nature of the organs of sense of the animals — be of consequence to them and such actions as are the results thereof. The outer world of animals is not the same as ours; low down in the scale only a very few exterior influences have any effect, and the outer world of such animals therefore differs enormously from our own. Hempelmann is of opinion that the biologist ought to consider everything as impulses and reflexes caused by organs of sense, by nerves and nerve-centres, without the intervention of mentality. If we were unable to draw

any analogy between the possibly existing mentality of the animals and our own mentality, we should have an animal psychology without a psyche, he says, and that inded is what he is trying to attain to. Even where Man is concerned he considers mental attributes to be pure epiphenomena which do not intervene in the course of causal-mechanistic events. This, to my mind, is less to the point than if he had confined himself to maintaining that there is a causal-mechanistic method of research which forces us to abstract from mental qualities, but we know that it is an abstraction. During daily occupation with animals, however, I maintain that it is undoubtedly practical to regard them from a psychical point of view as well, as do, among others, hunters and cattlebreeders to a very great extent. We have to admit, however, that the animal psyche is inaccessible to exact science.

With the higher animals, actions are often observed which naturally lead to the supposition that they are caused, or accompanied, by mental attributes which we think are comparable to our own state of consciousness, then it will often be found easier to describe the movements (behaviour) by means of psychical expressions than to describe the movements actually made, which last mentioned description, alone, is the proper task of descriptive biology. It is for instance much easier to say: The dog was frightened and ran away, than to have to describe all its expressions of fear and the subsequent movements of flight. It should never be overlooked that such application of psychical expressions necessarily provides a wider margin for individual judgment and colouring than is acceptable to science in the strict sense of the word. Only as a temporary means and for the sake of convenience should the easier, less

constrained but more inexact application of psychical analogies be adopted. With regard to the principle involved Huxley has said the final word in his remarks already quoted. I only want to dissociate myself from the dogmatic dismissal of every application of psychical analogies when describing the behaviour of living organisms. Such applications will offer certain facilities in daily practice. I desire, however, emphatically to point out that I can recommend only to the trained scientist of great experience and with deep knowledge of subjects and methods the benefit of those conveniences, not to amateurs who, perhaps more than anybody else, feel inclined to make use of them. As a consequence of this point of view, biology in a strict sense will do well to abstract from the psychical phenomena of living organisms and make the material processes alone the object of its researches. Thereby the advantage is further gained of removing the ever burning question of the relation between mind and matter beyond the scope of biology.

That such abstraction has in practice proved advantageous and practicable may perhaps by some be considered a proof that the mental qualities are not of such consequence to the life of the organism as is generally supposed, nay, that they ought even to be regarded, properly, as epiphenomena, as accompagnying phenomena, but on the other hand it must be conceded that the mechanistic method is far from being completely successful.

b. Biology. The Principle of "the Whole" and mechanistic Causality.

Provided I have rightly understood Huxley, he had no doubt that physiology, aided by physics and chemistry, would gradually explain all the phenomena pertaining to

organisms, with the exception of the psychical phenomena. This seems to be shown by his comparison of an organism to a whirlpool in a stream; the whirlpool remains while the particles of water of which it consists are ever changing, like the atoms and molecules of the organism; this comparison, he thinks, is as striking as it is correct, therefore purely mechanistic. When oxygen and hydrogen under certain conditions can form a quite new substance, to wit water, he does not consider it any greater peculiarity that atoms and molecules can form living protoplasm, i. e. living beings. When Huxley thus, in his able and clear manner, makes himself the spokesman of the hope that it may be possible to get to the bottom of biological problems by mechanistic methods, he openly professes adherence to the scientific spirit on which biology as a strict science is forced to draw. The superiority of the mechanistic method is so patently a fact that I consider it unnecessary to enlarge upon it in this connection. The object of biology, the living organism, is so complicated, however, that it has proved intractable, if treated from one single point of view, even from the scientifically desirable mechanistic one.

1. I. Kant.

I shall now mention another man, I. Kant who lived before Huxley's time and in many ways influenced him, although he did not look so optimistically upon the mechanistic explanation of the material nature of living beings. In his "Kritik der Urteilskraft" he — like Huxley — dismisses the use of psychical explanations in biology, but he distinctly dissociates himself from the thought that it should be possible to obtain a full understanding of the nature of organisms on the sole basis of mechanistic prin-

ciples; even if another Newton were born, says Kant, he would not, on that foundation, be able to explain the coming into existence of a blade of grass; yet Kant believes the mechanistic-causal explanation to be the only one that can give any real explanation of the organism, but this explanation cannot be completely carried through.

Kant has it, however, that there is another principle according to which organisms may be classified and described, namely the teleological or "purposive" one; but there are many kinds of purposiveness, not all of which are suitable for use in biology. It is more particularly the "internal purposiveness" which is of importance, as in connection with this organisms are regarded in the light of individual indissoluble wholes, both with regard to their form, the functions of their organs and their activities. This principle of totality need never disagree with the causal principle; where it is possible to carry through the latter, the former is superfluous.

The complex phenomena we encounter can be considered either from the point of view of "the whole" or from the point of view of "the parts". Only when it is possible to analyse them into parts down to atoms and reassemble them by the mechanico-causal method as for instance with a steam-engine is "the whole" explained. As a provisional method we may thus with advantage use the principle of "the whole" i. e. when describing and because we thus set problems to be solved on mechanistic principles; "the whole" in itself cannot be used as an explanation, — it would mean the introduction of a "vital force", says Huxley and rightly. "The whole" in itself does not contain more than the parts mechanically explained. The whole is not found only in the organic but also in the inorganic

world; as far down as the electrons we can probably speak about "wholes". Kant has used the conception of the whole on the organisms, Høffding has established totality as a category.

It may be asserted that the expressions "explanation" (by the mechanistic method) and "description" (from the point of view of the whole) are not really so essentially different, as both are really only descriptions proceeding from different principles. On practical grounds I keep to both expressions; "description" is of importance until "explanation" has been given.

In reality all science is only description, since we "know" only our own subjective conceptions and we observe only their contemporaneity or consecutive order, "post hoc"; we put certain series of conceptions together according to the formula "cause and effect" (causality), but we know only their succession. The cause "propter hoc" we have never seen and shall never see. We must here follow Kant.

Already in 1920 in his book on "The Unity of Science" Johan Hjort expressed his opinion on the position of Kant towards the principle of the whole. He maintains that during the whole of "Kritik der Urteilskraft" Kant has tried to find a possibility of using the same scientific principles and the same procedure of thought for the study both of living beings and of inorganic matter. Kant struggled especially against the difficulty of not being able to see the methodical order in the study of inorganic objects, which is something that biology has always assumed in its investigations of living beings.

In our days we regard the case otherwise than in the days of Kant, inasmuch as in chemistry and physics as as well as in biology we now assume "wholes" containing

different parts all doing duty in the maintenance of the whole: "Unity of Science". Hjort believes that wherever human investigation established "wholes" we must use ideas corresponding to the old teleological principles. The different sciences have gradually introduced different names for their ideas of "the whole". In biology we thus use the word "organisation", in physics and chemistry the word "system", in both cases we imply morphology or structure and function or activity. The connection of morphology with physiology, of organisation with function and of structure with activity is the teleological method in the natural sciences.

In biology where form is in most cases visible, form is most often the starting point of investigation, but in chemistry and physics where the forms (atoms) are invisible, their existence is deduced from the results of the activity of matter; but the course of thought is the same in all sciences — says Hjort. —

Biologists in this country have as a rule shown but little interest in philosophy, at least in my apprentice days it was almost a crime to talk about philosophy; but there is something that every biologists must realise, namely that biologists' and 'other people's' knowledge of animals and plants and everything else is only derived from the contents of their own consciousness and is a phenomenon of consciousness. In the valuation of this we must notice two points: 1) the special nature of consciousness and 2) the impressions received by this consciousness through the organs of sense from the environment, (surrounding world). Man hopes and has every reason to believe that the phenomena in his consciousness are at least roughly in accordance with what we naively regard as the external, the

real, world; and therefore we can construct science about the phenomena. It was Kant's starting point and fundamental theory, that natural sciences exist, and that in consequence we are able to deal with phenomena by means of scientific concepts.

To make science means to be able to predict by the help of constructed laws certain events, when certain others are given. With the principle "cause and effect" and several other principles (categories) Kant, according to his comprehension and the existing state of science, determined the à priori laws accepted by everybody bent on making mechanistic, that is real, science; these principles have been fixed by the nature of our own consciousness. The characteristic of such a science is that it tries whenever it is possible to use figures, measures and weight, and to such efforts we adapt suitable instruments. It would be well to remember, how much discussion about "warm or cold" has been made superfluous by the introduction of the thermometer, because with this instrument we are able to give figures for "warm or cold".

The laws established in this science about natural phenomena, which are especially used in chemistry and physics, we can now try to apply to living beings. With regard to this application Kant is on one hand of the opinion that we are unable to fix any limits for this method, and on the other hand that we cannot fully understand living beings by help of these mechanistic principles.

Here Kant has probably given a sober interpretation of our possibilities of getting knowledge about living beings. Therefore, if we take Kant's viewpoint as a base, it will confer the following advantage, that on principle there is no cause for conflict between the mechanistic principles

and the principle of the whole. Hence it will seem both natural and desirable to use within biology the mechanistic principles as well as the principle of the whole; cause for disagreement between the two points of view will not arise until unwarranted results are put forward, e. g. premature consequences of the observations made.

With regard to "the whole" there is, as is proved by the history of biology, a dangerous tendency to advance purely subjective and non-scientific theories; great sobriety and close connection with the recognized results of the mechanistic viewpoint is therefore an absolute condition for the useful application of this viewpoint. The nearer we keep to the sure discription of life-phenomena and the more we keep away from constructing theories, the better it will be. From the mechanistic point of view, the only point of view able to guide us to science in its strictest sense (Kant), it is also necessary to be careful not to push theory to extremes. And of such excesses the history of biology shows instances enough. It should here be specially stated that many scientists in their very efforts to protect the mechanistic method and to strengthen their trust in its power to procure for us the knowledge that should be the ideal of every scientist, have been deluded into overstepping their province in maintaining their point of view as the only justifiable one, and into trying to adapt the object of investigation to their method, thereby often doing violence to the facts.

The two principles of Kant have the happy quality that, rightly understood, they satisfy at one and the same time the severe claims of science and leave room for a larger scope, making it possible to raise and to answer questions that cannot be dealt with by strict mechanistic

science. The contribution of Kant is, however, in some directions affected by the low standing of biology in his day, but he has nevertheless in the main produced ideas which can keep us from mistakes even today. And he has also kept his ascendancy in biology; but he is often appropriated by people who in reality have not caught the fertility of his biological thought; the strong emphasizing of the view, that only the mechanistic method produces strict science, and his conscientious consideration towards the special features af biology — the study of the organism as a living whole. I have found it better to put Kant's point of view first as an orientation for the essays that I shall now mention.

2. Other authors.

Among physiologists the principle of the whole has been advanced especially by J. S. Haldane in England.

Haldane is of the opinion that, by examining the function of the different organs separately, we miss something that is essential to the living organism, because here it is the regulation of the activities of all the organs that is the essential. The maintenance of the normal conditions of the organism under ever-changing internal and external conditions is the assignable and characteristic feature of "life", the activity of the whole. It is true that this is a "teleological" point of view, says Haldane, but without this physiology would loose itself in a mass of details, the collective importance of which we would not then understand.

That is why he keeps aloof from T. H. Huxley in his "Elementary Lessons in Physiology", because here Huxley does not take into consideration the actually demonstrable activity of the whole, that is of such great importance for

instance for the physician. The fundamental axiom of biology is, that the normals of the organism depend upon each other and endure actively as a whole as long as "life" lasts. "The New Physiology", defended by Haldane, is therefore a biological physiology and not merely a biochemistry. In his opinion the attempt to reduce the living organism to a merely physico-chemical mechanism is probably the greatest error in the whole history of modern science.

Just as mathemathics do not suffice as a base for chemistry and physics, even if the laws of the first are accepted by the others, so chemistry and physics do not suffice as a base for biology, which must nevertheless also accept their laws to the full; but each science has its own axioms, thus biology has "life" as a whole, the living organism. Haldane asserts that mechanics are not enough in biology when considering the present state of the mechanistic sciences; but he does not think it at all impossible that these sciences with their ever changing theories about matter and force will rise and approach biology; but one thing is certain, he says, biology will never be able to put up with the present mechanistic view-points. The idea that the organism maintains its normal state is something that has no place in present mechanistic physiology.

Here Haldane somewhat approaches the "principle of the whole" as developed above by Kant. Neither of them can make any use of vitalism implying natural agents such as entelechy or psyche in combination with mechanistic causalities; but both use the "whole" as a fundamental alternative method of contemplating the organism in order to describe the phenomena of life. The activity of life is a "blind" activity, says Haldane; only in the higher organisms

do we find a mentality sufficiently developed to justify us in speaking about personality (individuality); here we have a new feature but its investigation would approach psychology, not biology. It is, however, only a small part of what takes place in these higher organisms that touches consciousness, so that even here it is possible to work undisturbed to a great extent. In the higher organisms everything is created by the living cells with a constant destruction, reconstruction and restoration; it is therefore in these cells and in their regulation (the whole) that we must look for the power that maintains normality. Even though these cells do not contain any permanent physical structure, for their apparent structure is only a whirlpool of molecules under the continuous influence of internal and external environments, the balance of the organism is not only active and adjustable but very stable, because it always adapts itself to the conditions of the environment; thus wounds heal up, microorganisms are fought and destroyed, torn limbs are replaced, and finally by propagation the whole organism is renewed. —

In "The Principles of Human Physiology 1926" Starling says: "In all physiological processes"... "adaptation will be found the constant and guiding quality" (p. 5). "Adaptation may indeed receive the definition which Herbert Spencer has applied to life" — "the continuous adjustment of internal relations to external relations" (l. c. p. 4).

We must remember that it is here a question only of the adaptation of the individual in ontogeny and not in phylogeny; adaptation thus viewed covers approximately the conception of Haldane and Kant concerning "the whole and the maintenance of the normal etc." The principle of adaptation is the only formula which will include all the

phenomena of living beings, and it is difficult to see how this principle can be expressed by means of the concepts of the physicist", says Starling (l. c. p. 7).—

In addition to the authors already mentioned many others have engaged in studies of the whole as a fertile help in the investigation of living things; I shall only mention H. Driesch, who, however, also introduces vitalistic points of view (Ganzheitscausalität), and E. Ungerer in several publications. The principle of the whole seems to them to be of great importance for descriptive biology, as it restricts the too uncritical use of purposiveness. Høffding (1925) has treated the problem from a philosophical point of view, and in the way that I have here presented the case, I believe myself to be in accord with him. There is no fundamental difference between mechanism and organism, but as Kant said, it is due to the nature of our understanding that we are under the necessity of using two methods, partly to go from the parts to the whole and partly from the whole to the parts, without, however, being quite able to complete either of the ways. The principle of the whole can not, however, be used as an explanation but only as a description and orientation. This description cannot attain to scientific objectiveness, but suffices for an orientation which, though subjectively colored, is nevertheless for the present indispensable.

As has already been stated, the principle of the whole has great importance for descriptive biology; and by de scriptive biology I mean not only the immense literature concerning description of new species and their characters (systematics) but also nearly everything that is generally comprised in the word biology, as for instance anatomy, morphology, embryology, ecology etc.; even physiology in

its extended application of physics and chemistry forms only partly an exception, because, as Driesch says, 90 p. c. of it also is only descriptive biology.

C. Application of the Principles.

a. Morphology.

The fundamental question for the descriptive biologist must be how to use the principle of the organism as a living whole. With the whole as a starting point the form of the organism is already given so that it is not necessary to wonder so much at "purposiveness" or "adaptations" as we did in former days; because it is impossible to imagine the existence of an organism which is throughout unpurposive; with the whole as really existent this is given. The flying bird has wings to fly with, otherwise it would not be a flying bird; swimming birds only use the wings to swim with, otherwise they would not be what they are. Plant-eating mammals have teeth adapted to deal with the different kinds of plants necessary for the different species, otherwise they could not exist as herbivores. If in thinking about a whale we imagine everything taken away that is adapted to its life in water, there will be very little left.

The wholeness of form is thus given with our starting point. Now it is true that the principle of the whole as a category or as a logically established concept is not easy to work with in biology, since it is only relative wholes that we have to do with. To-morrow the organism does not contain the same atoms and molecules as to-day; many are replaced by new ones, whole cells have disappeared inside the body as well as from the epidermis. The leaves change every year on many plants; in the lower organism it is not even easy to decide what must be considered as

an individual, and so on. Besides, we must remember that in biology we abstract completely from the mental qualities; they are not included in what biologists call the whole. The principle of the whole can, however, in many domains be of great use for the descriptive biologist; where he uses this principle he is not lost in a too loose use of "teleological" descriptions. It is only too easy to use teleology in every isolated detail, says D'Arcy W. Thompson (Life and finite Individuality. Two Symposia 1918 p. 58) such as the form of a leaf or the colour of an eggshell; the zebra is striped, so that it can browse undisturbed among the high grass; the yellow lion is yellow as the sand of the desert, in order to be undisturbed there, many arctic animals are white as the snow etc. Many dogs have a yellow spot over each eye, so that they may look, when asleep, as if their eyes were open. Many mimicry-phenomena have probably been interpreted in this too easy way; such an uncritical use of teleology interferes with investigation of the real explanation of the phenomena and is to be avoided. So long as we keep to the principle of the whole, we stand fairly clear of these stumbling-blocks, but further than to recommend this in a general way, I can hardly go; I shall try to show how this point of view can be utilised.

Perhaps the theory of Kant, that everything in a organism must necessarily be of fundamental importance for the whole, has helped to foster such on exaggerated use of the principle of teleology; such an effort to understand everything has probably had importance for the recognition of the part that many organs play in the organism, but not all organs or formations in animals and plants have such an importance; this must be established in each case by exact

trials or experiments; it is not enough to guess: This sin has been widespread in biology both in the zoological and in the botanical field.

There can be no doubt that the form and structure of organisms are the result of inherent forces and their activities. Activity is as characteristic of the phenomena of life as form, if not more so; also the regulation of the functions, that keeps the organism together, (and this applies both to animals and plants), must be regarded from the point of view of the whole: the wholeness of the functions. The functions of the parts, even down to the activity of a single cell in a complex organism, are subject to the whole. In most cases the organism begins its ontogenesis as a single cell, the fertilised ovum, and the development of this ovum to a grown individual, the shorter or longer life of this individual and finally its transmission of life to the next generation, together form a complete whole (Ontogeny). In the investigation of the separate functions we encounter the mechanistic explanation, and the question therefore presents itself, what can we explain and what can only be described, mechanistic explanation against the description by help of the whole. Here we can, from a zoological point of view, draw good help from E. S. Russell's book (The Study of Living Things 1924).

To be sure his point of view is on principle not quite the same as those above mentioned, in that he thinks that mental qualities play a causal part as far down as the amœba, and that it is necessary to give consideration to psychic qualities on account of their visible manifestation; it is, however, only when treating the behaviour of animals that he uses psychological conceptions; outside this domain, and there is much outside this domain, we must use the

principle of the whole, that is "Responses or activities of the organism as a whole, and functions or activities of the parts"; hereto must be added the actual domain for mechanistic science, that is, the material conditions of life, where mechanistic explanations are absolute.

Russell considers, and with reason, that activity is the most characteristic quality of living beings; however when he considers activity on a psychophysical basis it does not play a great part in his practice, the principal purpose of which is to work out a functional biology; he wishes first and foremost to establish 1) that a full physico-chemical comprehension of the organism is quite impracticable, 2) that vitalism causally mixed in the practice of such a comprehension is inadmissible as a working hypothesis, 3) that biology is an autonomous science which has its own domain and must use its own methods of work and its own concepts. This point of view is really not far from the above mentioned point of view of Kant, i. e. 1) that we should go as far as possible with the mechanistic explanation, and 2) that we should use with caution other ideas (the whole) in descriptive biology, while 3) the question of vitalism or no vitalism is treated as of lesser interest. The main difference between Russell and the principles here put forward is, that Russell thinks he is able to observe manifestations of the wonderfull activity in the lower organisms as far down as the amœba, and that this activity is of a psychical as well as of a physical nature and must be so interpreted, while we believe that where the mechanistic explanation is not practicable, strict biology has only one way of regarding the phenomena of life, that is as wholes, and this, as we have already stated, gives only a description of these phe-

nomena, a description of great importance for descriptive biology, that is to say almost the whole of biology, but no explanation. Russell mentions (The Study of Living Things 1924, p. 112) how a bone preformed in cartilage is formed with all the gradually appearing functions of cells, by which an ossified bone gradually arises; he points to the orderliness with which everything takes place in the functions of thousands of cells, and he thinks that it is hopeless to look for a mechanistic explanation of all the part-processes; we should then only get lost in details not be able to "see the wood for the trees". And if we go asking why the bone is developed just in this position, and with such or such future meaning etc. then we are not able to give an answer if we do not consider everything in relation to the organism as a whole, i. e. consider the meaning of the bone later on in the fully developed plan of the organism (Finality). P. 111 Russell says: "no single biological function can be fully understood if it is treated merely as a physico-chemical event, — all that can be gained by such procedure is to establish the enabling and the limiting condition of its occurrence".

In one of his other publications Russell mentions an instance (quoted by J. Arthur Thomson: Animate Nature I 1920 p. 160 ff.) of a special kind of wholeness, i. e. the life-history of the eel from the point where it leaves the ovum, (this point has perhaps not yet been established), as a larva of few mm. in the west of the Atlantic, drifts for several years with the current towards the coast of Europe as a leptocephalus, turns before arrival in the coast waters of Europe into an elver, lives many years there in order at last to leave these waters after having developed from a yellow to a silver eel, seeking probably once more

the west of the Atlantic in order to spawn. The life of the eel as a leptocephalus is of long duration, it must be passed in water that does not freeze during the winter nor has too great variations of temperature; therefore it must be passed in the great open waters. The elvers must have much food in order to become grown eels and this they find most easily in enclosed waters with their rich animal life etc.

This migration forms so to speak a series of facts that are of a higher order than mere physical and chemical facts, says Russell. In order to understand them the biologist must consider them as a whole of which the signification is the continued existence of the eel; for the mechanist there are no facts concerning the migration, for him it is only a question of internal chemical reactions; but for the biologist it is the migration as a whole that is the fundamental fact, while the basic chemical processes are so far of little interest. —

We see how near each other are the line of thought of Russell and that of Kant; either we use mechanistic causality or the principle of the whole as a guiding principle, but we also perceive that Russell underlines the limitations of the mechanistic method in a way that in my opinion is too strong.

b. Physiology.

As Kant states, we must try to understand living beings by help of the mechanistic sciences, especially physics and chemistry; it is therefore of interest to see in a general way how far we have got along these lines.

H. v. Tschermak declares in his big Allgemeine Physiologie (I Bd. 1916—1924. 796 pp.): "Hätte die Physiologie

die Aufgabe, Lebensvorgänge durch restlose Zurückführung auf Erscheinungen am unbelebten Stoffe zu erklären, sie hätte so gut wie noch nicht mit der Arbeit begonnen" (P. 36).

He refers to the above mentioned famous declaration of Kant in his "Kritik der Urteilskraft" § 75, that even if a new Newton arose, it could not be expected that by help of the mechanistic laws of nature he should be able to make us comprehend the growth of a blade of grass, since these laws do not contain the idea of totality or the principle of the whole.

The English physiologist E. H. Starling declares in his Principles of Human Physiology 1926. p. 1.: "In the unicellular animal all the essential functions which we associate with living beings are carried out often simultaneously, in one little speck of protoplasm. An analysis of these functions, the determination of their conditions and mechanism is obviously impossible under such circumstances. It is only when, as in the higher animals one part of the living body is differentiated into an organ, which has one function and one function only as the outlet for its activities, that it becomes possible to peer into the details of the function with some chance of discovering its ultimate mechanism". —

The functions of the living cells are still a mystery in physiology and the idea of adaptation in the life of the individual is very nearly related to the principle of the whole, as stated by Haldane, and the maintenance of normal conditions.

L. Cuénot (L'Adaptation 1925) says p. 384: "La grande majorité des organes ont une fonction qui est leur fin, de sorte que la physiologie pourrait s'appeler la science de la

finalité des organes, en effet la tâche du physiologiste est de découvrir l'utilité des parties ou leur corrélation avec des processus utiles".

Many physiologists would certainly not be satisfied with such an interpretation of the programme of physiology; they commonly emphasise the physico-chemical side of organic functions; but more or less unconsciously they nearly all use the idea of the whole in their investigations.

I do not think that I am far wrong in stating that a very great part of physiology (90 p. c. says Driesch) is really descriptive biology, supplemented by a great deal of knowledge about the chemical processes which take place in the organism, more often outside the living cells, and by knowledge of a great many mechanisms which are to be found in organisms, which mechanisms always start and end with the functions of the living cells and therefore can probably never be fully explained, and finally by the knowledge of the physico-chemical conditions that generally determine and influence life; here I have in mind both external and internal environmental conditions. In all these domains much has been attained, e. g. for the good of medical science; I have only to cite serum phenomena, hormones, vitamins, enzymes etc. But the mystery of life remains unsolved by physiology, and it will probably always be so. It is not by chance that in physiology we speak of a "stimulus" as producing a "response", because if we knew exactly what took place mechanically, we should probably speak of cause and effect.

In the domain of detailed anatomy we have attained great results, that form the basis of modern surgery, the practical importance of which is very well known. The study of the biology of microorganisms, which has been

carried on in close relation with medical science has also produced great practical results for the good of humanity, but it is only a branch of descriptive biology.

Reflexes which are performed without the influence of our consciousness are by certain investigators considered as following a purely mechanicistic course; but even if we know many of the mechanisms in a general way, their entire course is far from being mechanically understood, they begin and end with the function of living cells; they contain the "mystery" of life.

"Purposive" actions can be executed by a frog without a head, consequently without the collaboration or attendance of consciousness, in the same way that so many innate instinctive actions are performed; but it seems difficult to interpret, for instance the nest-making of birds in the breeding season solely as the outcome of physico-chemical conditions in their body, notwithstanding our knowledge that removal or transplantation of the sexual glands has a great influence on the behaviour of many animals. Here we are practically obliged, in addition to the mechanistic point of view, to use also the point of view of the whole as well as the psychical point of view. These three points of view should, however, be kept carefully apart.

c. Organism and Environment.

It has been mentioned above, that Haldane has established the continual adaptation of the individual organism vis-à-vis its environment; he has for example studied the adaptation of human respiration in high mountains with rarified air; such an adaptation he states is a general phenomenon in all changing conditions, — the normal is maintained. He says at p. 122 (The New Physiology 1919),

that: "The life is a whole of which the elements cannot be isolated without changing them. The whole is in all the parts, including the environment". This close connection between an organism and its environment cannot be often enough insisted upon. I shall never forget the first time I discovered that many marine animals and marine plants can hardly be seen, when not under water; if out of water they collapse into slimy non-recognisable bodies, without form; even a vertebrate such as a fish fares badly out of water. Here we take chiefly the outer environment into account, but the inner environment in the body itself is of equal importance; blood, lymph, the air in the lungs, the food in the digestive canal can be considered both as environments and as parts of the whole, and perhaps there are similar conditions in the contents of each living cell, only we do not know to what extent, says Haldane. This combination of structure, environment and activity is precisely "life"; they cannot be separated without the breaking down of the whole. He opposes the wholeness of life to the mechanistic point of view; that is essentially the point of view of Kant.

Uexküll (Innenwelt und Umwelt der Tiere. 1921) maintains similar view-points in a way very productive for biology and shows that there are as many different environments as there are organisms; each species is influenced only by incidents accessible for itself, and these incidents are determined by the organisation of the organism in question. For a gnat the world has another aspect than for a human being; a gnat has only gnat-interests; it is up to the biologists and physiologists to examine what these interests are. Uexküll distinguishes strictly between technical biology and mechanistic biology; the first

is specially devoted to the activity of the living cells, the phenomena of protoplasm among other things, the entire ontogeny, with its creation of forms, regeneration etc. where supermechanistic powers are specially conspicuous. The highly developed mechanism of the grown animal can better be investigated in the causal-mechanistic way as stated above. He is a vitalist and he refers to "plan" in nature; he does not like to refer to "purposiveness" on account of the too human anthropomorphistic origin of this idea. The supermechanistic powers of protoplasm appear, as above stated, in the form-creation of the individual, in the regeneration of parts of the body, and finally also in regulation; all this makes a "whole" of the organism. Machines have nothing corresponding to these powers. But the more highly developed adult animals have much structure that can be examined almost as the mechanics of a machine, and mechanistic physiology generally keeps to this, and leaves the protoplasm-problems alone; they can only be described, not explained.

d. Ontogeny (Development from Ovum to Adult).

"A number of factors are transmitted from parents to the developing egg. These are the internal factors.

These factors work in connection with others situated in the environment . . . At present, however, it is necessary to enquire whether all the internal factors operating during various stages of development were actually present in the fertilized egg.

The answer is no. If in the 2-cell stage of the frog's egg one blastomere be killed with a hot needle, the other will develop mosaically as a half. On the other hand, if the dead blastomere were removed, the remaining one

would become spherical, regulate itself, and develop as a whole. Therefore one of the factors which in normal development ensures that a blastomere of the 2-cell stage will produce half the embryo, is the presence of the other blastomere. But the presence of this blastomere is not a factor which exists as such in the egg.

Not only are these factors in the egg, then, but there are others which partake of the nature of mutual relationships, positions, and interactions of parts, factors which are not present in the egg, but are indirectly due to those in the egg. These are of increasingly great importance in the later stages of development. Although internal to the organism, they are often more accessible to influence by external conditions". (G. R. DE BEER: An Introduction to Experimental Embryology 1926. p. 51 Oxford).

This new method of investigation (Entwicklungsmechanik) established by ROUX has carried the problems a step further than the older comparative method, but both continue to be what I call descriptive biology; one method uses chiefly the knife, microscope and microtome, while the other, the experimental method, uses in addition a modification of the conditions of development by the help of chemical, physical and organic operations; they both work on the same problems, and they are supplemental. In ontogeny we can thus talk about internal environments formed mutually by the different cells which are of fundamental importance for the course of ontogeny.

E. G. CONKLIN (Heredity and Environment 1922) speaks about "creative synthesis" in ontogeny, and is of the following opinion (l. c. p. 31). "But just as in the union of hydrogen and oxygen a new substance, water appears, which was not present before, by a process of "creative

synthesis" — so new functions appear in the course of development — created by the interaction and synthesis of parts and functions previously present".

l. c. p. 59. "but even the most highly organized egg is relatively simple as compared with the animal into which it ultimately develops. Increasing complexity, which is the essence of development, is caused by the combination and interaction of germinal substances under the influence of the environment".

Thus just as in the formation of water, there is no question of development of something pre-existing, but new qualities arise by the "creative synthesis". In the course of development something new actually emerges which cannot be said to have been predestined in the ovum. We are here face to face with an interaction of cells belonging to the body and the germ-cells, which cells cannot at all be distinguished at the start. All the first blastomeres are alike (equipotent); most plants can from a single vegetative shoot create a whole plant with its flowers and germ cells.

Similar thoughts are expressed by C. Lloyd Morgan who uses the term "emergent evolution" instead of "creative synthesis".

We might also say that the characteristic powers of reaction of the ovum and the environments (the internal and the external) are two factors of which the product is the developed organism; we do not know how much is due to each factor, but probably the environments can influence the germ-cells, that is the nature of the future eggs by "mutation".

If thus we remember, that under ontogeny we include both external and internal environments, we can easily understand that these can be of great importance for the

development of the organism through "creative synthesis" and here we get near to the big question of preformation or epigenesis.

If, as has been believed by some in old days, everything is preformed already in the ovum, then all evolution (phylogeny) is thereby excluded. The entire organism was considered to be present in the ovum, only in smaller size, it was then only a question of expansion. Such ideas are not now in vogue, as the microscope has proved their falsity. The modern idea nearest to that stated above is probably the one which says that the whole organism is given in the ovum as a sort of chemical formula, but that the environment during the ontogeny may to a certain degree modify this organism in a "superficial" way, after all a kind of preformation. Others think that no doubt there is something characteristic in the ovum of each species, consequently some preformation; but that during the ontogeny new creative forces are added, consequently epigenesis. How much is due to preformation and how much to epigenesis cannot be decided upon yet; it is an open question, as is almost everything concerning the course of ontogeny outside the purely descriptive facts.

e. Phylogeny (Evolution).

In phylogeny we approach a domain of biology where the historical idea is the sole prevailing principle. ADOLF MEYER speaks in his interesting book (Logik der Morphologie. 1926. 265 pp.) about "historical causality". "Phylogeny as a historical science need not at all be concerned about the fact that premature (voreiliger) physiological theories renounce its explanations", says Meyer; and he is surely right. The working biologist can not in practice

get on without theories, especially not without the theories of natural selection and Lamarckism, even if he knows that they do not contain more than a part of the "explanation". They have proved good working hypotheses, Lamarckism expecially when treating of the higher vertebrates. (See H. Winge: Pattedyrslægter. I—III. 1923—24). Founding his views upon a detailed knowledge acquired through many years' work on the anatomy and biology of the vertebrates as well of existing as of extinct species, Winge has arranged their systematic relationship in the form of a genealogical tree; he maintains the theory that the activity of the vertebrates, in order to maintain life under changing conditions, has modified them (the heredity of acquired characters), and that the systematic groups can be understood in all details when due regard is paid to their mode of life. He is consequently a Lamarckist. He further tries to discover which mechanistic causes have produced the modification of the animals, and here he is not always succesful in his conjectures. The whole work proves how the theory that it is the activities of animals that have modified them throughout the ages is an indispensable working hypothesis for the zoologist and the paleontologist; he has no other guide to put in its place. The "natural selection" of Darwin can only remove what is not fit to survive and preserve what is fit to survive; it cannot produce anything new.

We have seen above that the life-history of the eel can only be "described" by the biologist and cannot pro tem be explained by the physiologist, and nobody can with reason blame the supporters of the two methods; they must be allowed to follow each of them their own ideas; the views of both have advantages and drawbacks. In the

case of the eel we have been able to follow its ontogeny from ovum to adult, and we have seen how this ontogeny has been determined by the environment at the different stages, and there are many similar cases concerning the life-history of the lower animals, a very fertile domain for descriptive biology. The higher mammals with the embryo in the body of their mother, are more difficult to observe directly during the course of ontogeny, and its course is more cut off from the influence of the external environment; but even in the life cycle of the higher organisms we cannot get away from the idea that they have evolved gradually from something more primitive and that in all organisms there is hidden an entire historical evolution; it is therefore natural to consider organisms as historical beings, their form and life-cycle embodying history, and to describe their ontogeny as a kind of organic, not psychic memory, at least as long as we can not form a better working hypothesis. As descriptive biologists we must in general assert our right to work with our own methods, independently of the theories of other sciences, so long as they cannot give us something positive and better.

About the biogenetic law or rule as now generally interpreted I only wish to say that, as the structure of the ovum has in the course of time evolved into greater complexity, the course of ontogeny can of course not be apprehended as an unaltered recapitulation of all the phases of phylogeny, but some of these are more or less changed or have completely disappeared; however, facts prove that ontogeny contains a great deal of history, and a critical valuation of this history will often be of great help to the biologist when it is a question of establishing relationship

between different systematic divisions of organisms, of which the relationship of the fully developed individuals is not easy to trace e. g. in the case of parasites.

Latterly serum reactions have enabled us to test "the chemical relationship" between the proteins of kindred animals; and the results of this method have on the whole agreed with the genealogies established by the zoological systematist. In botany this method has also been applied in order to test chemical relationship among plants and here also the results of systematics and of chemical reaction have agreed. I shall only refer to a treatise in "Leopoldina", Halle. vol. 2. 1926 by Carl Metz: Die Bedeutung der experimentellen Systematik für die stammgeschichtliche Forschung.

Here appears a new experimental branch "experimental systematics" and we have thus three branches including the "experimentelle Entwicklungslehre" and the "experimental theory of heredity"; they have all carried the problems of biology some steps further on; they have not however outstepped descriptive biology and they will not do so before the problems of the living cell have been solved. And the solution of these problems will keep us waiting for some time yet. The purely mechanical imitations of living cells, that have been constructed, have nothing more to do with real living cells, than the movements caused by the wind in the leaves and branches of a tree have to do with the life of the tree. —

I would not mention modern genetical research if it were not that a defence is required on account of its attack upon the hypotheses of descriptive biology.

When we learn that some of the later students of heredity are of the opinion that all the "genes" were represented

in the primitive amœba from which among others certain mammals are supposed to descend, and that evolution (phylogeny) consists only in the dropping out of genes, then I think that we biologists must be allowed to remain sceptical towards this evidently highly unsettled science and unaffected by the fact that they think they are able to refute the truth of our good old hypotheses. If we left them, we might easily fare as the Protestant and the Catholic when discussing the value of their religions; as is widely known it ended by the Protestant becoming a Catholic and the Catholic a Protestant.

In order to prove the uncertain attitude of the experimental science of heredity towards the great questions of phylogeny I shall only quote H. PRZIBRAM: Experimental Zoologie vol. 3. 1910. p. 245 to which he himself in a letter of 1927 has called my attention, concerning the question of the "heredity of acquired characters". "Die Umformung der Arten erfolgt viel mehr unter der Einwirkung der äusseren Faktoren in gerade Richtungen (Orthogenesis-Eimer).

a) Die durch äussere Faktoren hervorgerufenen Veränderungen am gesunden elterlichen Körper können auf einem bisher noch unaufgeklärtem Wege in adäquater Weise auch am Keime auftreten, ebenso
b) pathologische Defekten und
c) Instinktvariationen,

wobei jedoch ein Erblichwerden bestimmter Localisationen von Gebrauch Verstümmelung oder Erinnerungen herrührenden Eindrücke nicht einwandfrei nachgewiesen erscheint".

Notwithstanding all that the later study of heredity has really achieved especially as regards practice, I think that we can say with Haldane (The New Physiology. 1919

p. 16) that heredity, or as it is sometimes metaphorically expressed, organic memory, is for biology an axiom and not a problem.

The results of the experimental investigations on heredity are principally to be found within the domain of the species, and it is true that the contents of this conception are better know now than before, but if, from the hybridization of races within the species, any one draws the conclusion that similarity between organisms does not signify relationship, then we must protest, because this contains only a small percentage of truth. Nobody will probably deny that the members of the great systematic groups as for example mammals, birds, fishes etc. are more nearly related to one another than for instance birds to fishes. It is along such great lines in the relationship of animals that phylogenetic zoology works, and it is from such facts that it has been able to form its own theories of evolution. These theories cannot, at least at present, be affected by the results of the studies of heredity within the species; they are based upon an enormous accumulation of historical facts, both morphological and paleontological, and have proved to be good working hypotheses; we shall keep to them for the present, just as we shall leave genetic research to its own working theories. Here I just want to state that genetic research uses other systematic entities than do systematics, palaeontology and phylogeny. These tree sciences are based upon the "Isoreagents", that is, individuals which, given the same environments, are alike in appearance; this is precisely the principle of identity (C. Raunkiær: Über den Begriff der Elementarart im Licht der modernen Erblichkeitsforschung. Zeits. für induktive Abstammungs- und Vererbungslehre. 1918. Bd. XIX Heft 4).

If certain students of heredity refuse to accept our working hypothesis concerning descent from a few primitive types, which enables us to think of their relationships as representing a genealogical tree, but prefer to consider descent as a sort of "rye-field", each little group descending from its original form, all in parallel lines, this theory is of no importance to the historical view established by zoology; we leave it willingly to the geneticists, if it may be of any use to them.

D. Recapitulatory Remarks.

Above I have tried among other things to give an insight into the application of the principle of the whole in several domains of biology. I have laid stress upon the justification of this view-point in combination with the mechanistic viewpoint, if only we remember its shortcomings when compared to the mechanistic theory as conceived by strict science. I have tried to show that we must, at least provisionally, use the principle of the whole, unless we withdraw large and important domains from biological research. On account of the importance of the question, I shall conclude this section with a résumé of my ideas.

The principle of purpose (finality) is derived from our own consciousness. We try to realise a future purpose by making the decision to reach such a purpose in the future; it thus seems, as if something not yet existing acts on something existing or something past, a situation that would be quite incomprehensible without a personality to direct the whole series of events in the future, as when for instance a man gets an idea for a machine and little by little succeeds in making such a machine. We are accustomed to

such events produced by our conscious psychical efforts, but even when it is a question of our own body, it is only very little that we can ascribe to such efforts; the whole genesis of the body from ovum to adult is realized without our conscious cooperation, and even in the embryo are formed organs to be used only in the future, — eyes that cannot see, lungs that cannot respire etc. The final importance of these organs lies in the future, and thus it is with the genesis of all animals and plants. Just as the egg-cell is a very small living cell, so all its successors composing our body are also quite small living cells, and to them we must look for at least a share of the explanation. The cells divide, grow and change, but how and why, they have never betrayed. Everything takes place surely according to fixed laws, but the whole is a marvel, at least something that has not yet been given an explanation, it can only be described. Some people imagine as above mentioned, that everything takes place on a strictly mechanical, physico-chemical basis, others, the vitalists, think that immaterial factors lend a hand. Between these two viewpoints we cannot decide, not yet at least, the question remains open.

The question of mechanism or vitalism is perhaps only a question of the point of view. Either "matter" is "alive", i. e. has such powers that under given conditions organisms may arise, or "life" is something other than "matter", something that with the assistance of matter can make organisms. The mechanist must presume that "matter" has such powers, because "life" is a fact.

As stated above, we cannot presume that consciousness, such as we know it in ourselves, reaches far down in the scale of creation or in ontogeny; but if we follow the mechanistic point of view, we are forced to presume fore-

runners to consciousness as far down as the atoms. In the fully developed organism are formed a large number of structures that may in part be described mechanistically, the function of muscles and nerves, the construction of sense organs etc. But everything in the description ends and begins with an x, the living cell; only what lies in between can be observed.

This applies especially to the functions of the organism, but their structure also presents the "problem of purposiveness"; they are "adapted" as we are wont to say. We do not in biology regard vitalism as a fertile working hypothesis, because we cannot learn anything about the immaterial agencies, therefore we must try how far we can get with the problem in another way; first we must change the term of "purposiveness", because it is of much too anthropomorphic an origin. Each organism, which we regard as a whole both in structure and in function, and which exists for a shorter or longer time until it dies, must be able to reach its goal and must have the means of doing so; it follows, then, that it cannot be quite unadapted for this work.

For the maintenance of the whole many things are required; we commonly say, that it has been "purposively made". However, in biology it is better to speak of "whole-maintaining" and "whole-promoting" qualities and not about "purposiveness", because much that is objectionable may conceal itself under this term. We must further understand, that an organism only becomes really a whole when it is seen in its proper environment; the fish in the water, the mole and the earthworm under the ground and so on. The organism "chooses" (selects) the environment to which it is suited, else it dies. With the developed organism con-

sidered as a whole there is thus à priori a number of these qualities comprised that we are accustomed to call "purposive". In considering organisms as given "wholes" much of the "teleology" that is met with by biologists is really accounted for. The biologist must first and foremost pursue the "internal purposiveness" mentioned by Kant, which has to do with each organism as a whole, and which has given Driesch occasion to form the conception of "Ganzheitskausalität", with entelechy as a natural vital factor. Only in one case, says Kant, we must be allowed to get away from this "internal purposiveness", that is, when talking about the two sexes of a species; here it is a question of something that reaches further than the individual, and therefore it is an "external purposiveness"; but as the two sexes form one organized whole, we must make this exception, says Kant.

There is, however, no doubt that in biology we must make many exceptions of this kind (parasitism, etc.) and we must also recognise exceptions to Kant's supposition, that everything in an organism is of essential importance to "the whole"; there are evidently certain rudimentary organs that must be considered as useless (without purpose), they are heritages from ancient progenitors that lived in other ways and under other conditions. —

In order to understand why many biologists are inclined towards vitalistic conceptions, we need only remember what has already been mentioned, that it is natural for a biologist, who has much to do with live animals, to consider their nature in the same way as he considers his own; we are ourselves a higher psycho-physical organism, and we know from the way in which human beings make apparatus or machines that our psyche plays or seems to

play a part thas has purpose, while the rest of the work is purely mechanical. We have as a rule no doubt that the psyche of a mechanical engineer has in one way or another to do with the idea of the machine, and that the machine is made with no violence done to physical laws either by the psyche of the engineer or by the making of the machine (the conservation of energy etc.), but the psycho-vitalist forgets that actually we know the psyche only from our own personal consciousness, and that we are not justified in ascribing similar mental qualities to organisms so different from our own as for instance amœbas and plants, and that notably we cannot know anything about the importance of these qualities far down in the series of organisms. We dare not talk about "die Vernunft der Pflanze" or about mental qualities if by that we propose to explain all the "technics" and "purposiveness" that are to be found even in the lowest organisms. We must content ourselves with a description of all this, all knowing that "the purposes" are ascribed to the phenomena on account of the special quality of our own nature; therefore this purposiveness cannot explain anything in a causal way, but only in a descriptive way. We do not know what life is; here vitalism wages a fight with dogmatic mechanism, a fight that will perhaps never end and that is perhaps due to certain ultimately irrational qualities in the specific biological subject of investigation. The strongest objection to vitalism is that it is of no help as a working hypothesis; on the contrary, it tends to check the search for causal explanations; on the other hand vitalism is of importance inasmuch as it indicates a great number of unsolved problems that we should otherwise be apt to miss.

The question of vitalism or non-vitalism is, as it seems to me, an open question which, in any case, is of no fundamental importance at present; but so long as the activity of the living cell has not been mechanistically explained, we must be allowed to regard descriptive biology based on the principle of the whole, as a fully justified method in connection with the mechanistic methods. However, in making myself the spokesman of this point of view, I do so with the reservations recommended in the theory of Kant.

E. Conclusion.

As is shown in the above exposition, the biologist ought, whenever he wishes to construct science in its strictest sense, to make use of the mechanistic method. All other methods will easily lead him astray and on to anthropomorphistic results. We are, however, aware of the fact that biology cannot be said by a long way to have solved, or to be able to solve, its problems by way of the mechanistic methods. In whatever direction we look we are up against unanswered questions and unsolved mysteries. When nevertheless many investigators seem to shut their eyes to this imperfection of biology, this is probably due to the natural desire of these investigators to maintain the one working theory that can guide them towards the coveted goal, biology as a science in the strictest sense. It would hardly do to turn too strongly against these persons on account of this attitude, even if we must hold that they are "onesided", when we take into account the general state of the question. When, however, opposition is so often expressed to the views of the mechanists, this is no doubt due to the fact that those who think otherwise feel

themselves outraged in some of their pet-ideas, religious views, the question of free will etc. To such persons one may perhaps point out that they need not take the declaration of the mechanists to heart. The domain where the mechanist can talk with any authority at all is, as seen above, rather limited, indeed so extremely limited that plenty of room is left outside, really as much as anybody can wish for; and even if we imagine that one day mechanistics will succeed in giving a full mechanistic explanation of organic bodies as such, the question of the relation between these bodies and their respective "souls" (psyche) would still remain open. We must remember that biology works with abstractions, at least when treating of man, and also when treating of many animals, i. e. dealing with the body without the psyche. The method of strict science is only one point of view; "life" as a real whole including its psychical part is something more. Religion, morals etc. can in the main remain undisturbed by the hypotheses of mechanistic science, even if the actual results of science must be respected everywhere in human mental life; science can only throw light on various aspect of them.

Neither the biologist nor the physiologist can show what "life" really is, no more than the physicist or the chemist can show what "matter" really is, or the psychologist what "psyche" is.

With the occurrence of death consciousness and the functions as a "whole" disappear first; thus by a shot at a flying bird both these qualities may disappear instantaneously, but the different organs may continue their separate functions for a long time afterwards and the different cells die little by little. The interaction, regulation etc. have, however, ceased. Later on the forms of the body are

decomposed into inorganic compounds, that is to say, "the whole of the form" disappears; the hardest parts of the body such as the bones keep longest, but as a rule they also disappear into the inorganic.

If we imagine that human consciousness covers an area of phenomena, in the form of a circle, strict mechanistic science would only cover a sector of a few degrees of this circle, descriptive biology would cover a far greater sector, and all other mental activities much the largest part of the circular area. —

My chief aim in this study has been, as above mentioned, to try to make clear what principles are used in biology and with what right, when treating the phenomena of life taken in the widest sense of this word, and I have shown that sometimes we use one principle and sometimes another, according to which gives the best orientation; but one thing we must guard against, that is, mixing unconsciously the different principles. Thus a physiologist cannot very well speak about psychical elements playing a part in the process of digestion, unless he is a psycho-biologist; a doctor can do so because he knows that in treating human beings he would not go far with a purely mechanico-causal comprehension; therefore we often speak about medical art in contrast to medical science. It is not good either when an investigator of heredity appears to vacillate between the conception of "genes" as either of a psychic kind or of a purely structural nature. We must either use a purely mechanistic method or a purely descriptive method by help of "the whole", or we must adopt psychical viewpoints, just as a joiner uses now a plane, now a saw, now a hammer, and so on, but only one implement at a time, even if he is often obliged to

use them all one after another in order to get a certain piece of work done.

With respect to a bird that with great skill builds its nest in the breeding time, we can take three different viewpoints:

1) The psychical viewpoint. It is difficult to say how much psychic function is present in this act, but the nest is always built under somewhat different conditions, so that the act can hardly be considered as purely instinctive; but an elaborate pronouncement on the psyche of birds is outside biology proper.

2) The point of view of the whole. We can explain the nestbuilding, laying of eggs etc. of the bird as acts beneficial to the species as a whole. If the bird did not behave in this way, the species would not exist. We thus attain coherent description of the bird's behaviour.

3) The mechanistic point of view. We try to state what substances that may influence its behaviour are secreted in the bird's body during the breeding season, we know for instance how transplantation of the sexual glands changes an animal both in respect of its body and in respect of its behaviour; but we do not in this way get far with the explanation of the general behaviour of the bird.

Each of these viewpoints contributes in its own way towards a "comprehension" of the bird's behaviour.

This position with three viewpoints for the study of the organism, and none of them capable of being carried the whole way, is really rather unsatisfactory, but it represents the present position of science.

It should, however, be mentioned here, that A. N. WHITEHEAD (Science and the Modern World. 1926. Cambridge) has tried to get further, inasmuch as he considers the very

conception of the organism as a fundamental conception from which physical and chemical phenomena as well as biological phenomena may be deduced.

The use of such a conception would very much change our views of the world. How far we can get along this line, only the future can tell.

It was through the philosophical lectures of Jørgen Jørgensen published in 1927 that my attention was for the first time directed to the theories of Whitehead. —

During the elaboration of this paper I have conferred among other philosophers with Dr. phil. S. Ranulf and after he had gone abroad with Captain mag. art. P. C. Poulsen. The last mentioned especially has been of great help to me, and if I have succeeded in not sinning too much against the ideas of philosophy, it is due to him. I owe much gratitude to these two men for the time and work they have devoted to this matter. In the same way I am very much indebted to the Trustees of the Carlsberg-Fund, who have enabled me to work in this domain, so unfamiliar to me, among other things by defraying the costs of the investigation.

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CONTENTS

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