Uexküll, Jakob von (1926): Theoretical Biology

Natural Science falls into two parts, doctrine and research. The doctrine consists of dogmatic assertions, which contain a definite statement concerning Nature.
The form these assertions take often suggests that they are based on the authority of Nature herself. This is a mistake, for Nature imparts no doctrines:
she merely exhibits changes in her phenomena. We may so employ these changes that they appear as answers to our questions. If we are to get a right understanding of the position of science vis-a-vis of Nature, we must transform each of the statements into a question, and account to ourselves for the changes in natural phenomena which men of science have used as evidence for their answer.

Investigation cannot proceed otherwise than by making a supposition (hypothesis) in its question, a supposition in which the answer (thesis) is already implicit. The ultimate recognition of the answer and the setting up of a doctrine follow as soon as the investigator has discovered in Nature what he considers a sufficient number of phenomena that he can interpret as positive or negative on the lines of his hypothesis.
The sole authority for a doctrine is not Nature, but the investigator, who has himself answered his own question.

A man may have assimilated the conclusions of natural science in the form of doctrine, and may know how to employ them in speculation, according to the rules of logic; but he still knows nothing whatsoever concerning Nature—or at any rate, infinitely less than doesany peasant or gardener who is in daily intercourse with her.

In Nature everything is certain; in science everything is problematical. Science can fulfil its purpose only if it be built up like a scaffolding against the wall of a house. Its purpose is to ensure the workman a firm support everywhere, so that he may get to any point without losing a general survey of the whole.
Accordingly, it is of the first importance that the structure of the scaffolding be built in such a way as to afford this comprehensive view ; and it must never be forgotten that the scaffolding does not itself pertain to Nature, but is always something extraneous.

INTRODUCTION

Biology at the present day claims not merely a certain domain of the will, but also the possession of a peculiar theoretical basis of its own, which is in no way deducible from the fundamental concepts of physics and chemistry.

The need for elaborating the theory of biology made itself felt relatively late. So long as biological studies, such as zoology and botany, confined themselves to description, they needed, it is true, special methods for attaining to a clear arrangement of the great mass of facts, but they did not require a special theoretical foundation.

The investigation of the processes in the living organism followed the description of forms; and for that the basis furnished by chemistry, physics and mechanics sufficed. And so it came about that men learnt to regard the living organism as a physico-chemical machine.

Now Helmholtz explained the qualities as signs of an external phenomenon which proceeds parallel with their change. This external phenomenon remains for ever unknown to us. By his famous "trust and act," as the philosophy to be drawn from this latter conclusion, he actually declared the bankruptcy of physiological psychology.
For if the external laws of Nature are forever with drawn from our knowledge, then the proof that our psyche is under their control can never be adduced.

Up to this point the physical laws had been no more than hypotheses; now they acquired the authority of an article of faith, which was enthusiastically spread abroad by the lesser deities.
But it wasvery unsatisfactory for research to be obliged to base its entire structure on an article of faith which was in no way better than the dogmas of they better than the dogmas of the Church. And that merely because Helmholtz saw in the sense-qualities subjective signs of the actual phenomenon.

It was certainly a misleading assumption, but in no way necessary. As Helmholtz himself taught, the objects that surround us are constructed from the sense-qualities; and indeed, one person uses some sense qualities for the making of objects, and another usesothers. So for him they are nothing but signs or indications for his subjective use, and they assert nothing whatever with regard to a phenomenon that is independent of him.

No attempt to discover the reality behind the world of appearance, i.e. by neglecting the subject, has ever come to anything, because the subject plays the decisive role in constructing the world of appearance, and on the far side of that world there is no world at all.

All reality is subjective appearance.

The task of biology consists in expanding in two directions the results of Kant's investigations:—(i) by considering the part played by our body, and especiallyby our sense-organs and central nervous system, and (2) by studying the relations of other subjects (animals) to objects.

The impressions received by the subject always consist of sense-qualities, which it then arranges and connects into unities, which we call objects. Accordingly we have to distinguish in every object between two things:—(i) the sense-qualities, which Kant called the *material*, and (2) the arrangement imposed on them by the mind, which he called the *form* of knowledge.

And thus Kant endeavoured to establish the universal and essential laws, uninfluenced by any psychology whatsoever, according to which each mind collects experiences. This led him to setup the two intuitional forms of space and time, which are necessary for every experience. And if these seemingly simplest of the forms in which the mind finds expression, have, since Kant's day, become susceptible of further analysis, this merely means that the principle of analysis, as employed by him, has proved to be a discovery even more brilliant than was supposed.

THEORETICAL BIOLOGY

CHAPTER I
SPACE

Kant writes, " Space is merely the form of all appearances of the outward senses, i.e. the subjective conditioning of sensibility, by which alone intuition of the outside world is possible for us." The biologist would express this in the following way,—" The existence of space is dependent on the inner organisation of the subject's personality, which clothes the sense-qualities in spatial form."
This spatial form, however, is not the same throughout the various domains of sense, and it requires separate consideration for each.

A very momentous question now faces us,—"How can the intensive design of the psyche and the extensive design of the brain be combined asconcepts ?"
We shall often meet this question again.

OBJECTIVE AND SUBJECTIVE

As we advance, our investigations increasingly compel us to seek a clear definition of the concepts "objective" and "subjective."

We have shown that, in Kant's sense, there is no such thing as absolute space on which our subject is without influence. For both the specific material of space, namely local signs and direction-signs, and the form this material assumes, are subjective creations. Without the spatial qualities and the bringing of them together into their common form that apperception makes possible, there would be no space at all, but merely a number of sense-qualities, such as colours, sounds, smells, and so forth; these would, of course, have their specific forms and laws, but there would be no common arena in which they could all play their part.

We may satisfy ourselves as to this, and yet the distinction between objective and subjective has a real meaning, even if it be admitted from the first that there is no such thing as absolute objectivity.

In order to make very vivid what is meant by existence in subjective space, let us think of ourselves as condemned to move by swimming about in water, without eyes or organs of touch. In such a case, we should learn nothing from our swimming movements beyond the changing claims of our subjective direction-signs; we should learn absolutely nothing about forward movement in space.
Now if we imagine ourselves as having an eye that can release colour-sensations but not local signs, still that would alter nothing with regard to subjective space; the sensations of red, green, blue and yellow would indeed arise, but the colours would remain properties of our subject, and the inner world of the subject means likewise the world as a whole.
We ourselves would be emitting simultaneously sound and colour and filling the whole of space with our person. It would be impossible to draw a distinction between thoughts and feelings, on the one hand, and sense-perceptions on the other, because the latter could not become properties of objects. We should then be solipsists, in the real sense of the word.

As soon as localsigns appear, the world is transformed in a flash; space acquires places to which colours can attach themselves, and from the sensations of colour develop coloured surfaces. No longer do colours appear and then disappear, as our eye roams to and fro. The red circle over there remains red, even if we are no longer looking directly at it. And by so doing, it has acquired an objective existence independent of the optical activity of the subject; on the other hand, it remains dependent on its position in a space that has now become objective.

Even our own body receives a definite position inspace, which it can alter by moving the limbs in a certain way.
While our body becomes objective in this way, like all other objects of the external world, our ego remains of necessity subjective; for the ego, as the unity of apperception which builds up all the qualities into higher organisations, cannot have so much as a single local sign of its own.

From all of which it is possible to derive, as sharply and clearly as we could desire, the definition we have been seeking for "objective" and "subjective." Every quality is objective only so long as it remains in connection with a local sign; it becomes subjective as soon as this connection is broken. The local sign, when considered by itself, is purely subjective; as soon as it enters into association with any quality whatsoever, it becomes objective place.

CHAPTER II
TIME

Just as certainly as that there is no such thing as absolute space, so also is it certain that there is no such thing as absolute time; for both space and time are merely forms of our human intuition.

But we have been able to show that it is nevertheless possible to maintain a distinction between objective and subjective space, by introducing the possession of local signs as the distinguishing feature.

For the discovery of a specific material for time we are indebted to K. E. von Baer, who based his brilliant exposition concerning the subjective character of time on the moment as the specific time-quality. Felix Gross has revealed the close connection between time and apperception, and we are now in a position to form for ourselves a clear picture of the nature of time.

Apperception is a life-process, carried out in phases, each of which manifests itself through a sense-sign; this sign is the moment.

We must therefore employ the word moment-sign.

According to Kant, the unity of the apperception creates the unity of our ego, which, although destitute of local signs, is always furnished with a moment-sign. As a consequence, all psychic processes, feelings and thoughts are invariably bound to a definite moment and proceed contemporaneously with the objective sensations. Time envelops both subjective and objective worlds in the same way, and, unlike space, makes no distinction between them.

We have taken the localsign to be the smallest spatial magnitude into which the various qualities were poured in order to give us the atom: in like manner, we may compare the moment-signs with the smallest receptacles that, by being filled with a content of various qualities, become converted into moments as they are lived. Like the local sign, the moment-sign remains constant in its magnitude and intensity, changing only in its content.

Always and in every connection, time remains subjective, since it is boundup with the process of apperception ; it is only the measurement of time that can be termed objective, in the case where the accentuation of the time-signs results from a change in sound independent of our own activity.

The series of Roman numerals approaches the original type most nearly, except that in it every fifth stroke has a special shape, so as to facilitate by group-formation a rapid comprehensive survey. The series of Arabic numerals has aspecial sign for each stroke from 1 to 9, and thereby offers important advantages for group-formation. For each Arabic numeral signifies not merely a certain stroke in the series, but also the whole group beginning with the first and ending with the stroke in question.

It is interesting to find that, at first, group-forming by writing lingered behind group-forming by special words for the numbers; for spoken Latin, unlike written, possessed ten different designations for the numbers from 1 to 10.

CALCULATING AND ESTIMATING

Since it is possible to count up everything of which we can so much as form athought, the resulting confusion has led to the development of the art of arithmetic, the first principle of which requires that we shall reckon together only those things that have the same denominator. Thus it is inadmissible to add ½ and ¼, ½ must first be transformed into 2/4, and then we may calculate that ¼ and 2/4 = ¾. In the same way, we must not count up 3 apples and 1 pear straight away. The apples and pears must first of all be brought under the same conception of "fruit"; then we may calculate that 3 fruits and 1 fruit = 4 fruits.

The life of two human beings who were born on the same day and who died on the same day, may be very different as regards duration and in richness in experience, even if their fates be identical.

As the local sign represents for each human being the absolute measure forspace, so the moment-sign gives him the absolute measure for time. It is only when we compare two individuals with one another that the two measures become relative; but we must not conclude from this that there is such a thing as a real space with its absolute measurement, and a real time with absolute measurement.

The attempt to introduce absolute space and absolute time comes from the observer who is investigating the relativity of two subjects necessarily taking as the basis of comparison his own time and his own space.

The illusion of absolute time is heightened by objective measurement of time, which tries to read off from the same clock everything that happens in the world from the Pole-star to the Southern Cross. As is well known, the most modern physical theories have shaken this doctrine to its foundation.

THRESHOLD

Threshold means the just perceptible difference between two intensities of a quality. It can be used in the same way, however, to mean the difference perceptible between two qualities. If we compare together two adjacent local signs, it appears that the difference between them is so slight as to be inappreciable, i.e. it lies below the threshold.

If that were not so, and if each local sign lay alongside the next without there being any intermediate steps, the whole world would consist of coloured points. It is only because the difference between two adjacent local signs is imperceptible that the world-picture is continuous, for continuity means nothing but an imperceptible transition, in contrast to one that is abrupt.

The same holds good for direction-signs, whether they be objective or subjective. It is merely because the difference between two adjacent direction-signs lies below the threshold that a movement appears to be continuous.

The continuity of time depends also on this state of things. If the moment-signs were perceptibly separated from one another, our life would proceed by tiny, separate jerks.
For a continuous movement to be appreciable at all, several conditions must be fulfilled. Not only must the movement include more than two direction-signs if it is to be perceptible, but the direction-signs must stand in the right relation to the moment-signs. If all the direction-signs are comprehended within two moment-signs, then the whole path traversed is interpreted as a synchronous unity, and the movement is suppressed.

But even if there be asufficiently large number of moment signs as well as of direction-signs, the movement may yet pass unperceived; as, for instance, when one direction-sign falls on several moment-signs. The movement then remains below the threshold, because the content of one moment-sign is not appreciably distinguishable from that of its predecessor; for the observer, this means that nothing changes.

The rule that a movement is perceptible only when its gradient is neither too steep nor too level, is rendered intelligible through the introduction of threshold; moreover, this concept makes it more clearly defined. Movement must be slow enough for all the direction-signs to occur within three moment-signs, and yet it must be fast enough for at least two direction-signs to occur within each moment-sign. If these conditions are unfulfilled, then no movement is initiated; everything is stationary.

CALCULATION OF THE RULE OF MOTION

In order to make susceptible of calculation the relations between these fundamentalqualities of space and time, it is necessary to consider them as world-factors. So long as we consider local signs, moment-signs and direction-signs as mere qualities of our mind, they remain three non-comparable magnitudes. But each of these elementary magnitudes has its task to perform in the world, and then it comes into correlation with the other magnitudes, which can be expressed in numbers.
For all three qualities, the task prescribed is the same.
Each serves as the smallest receptacle or the smallest frame for other qualities which, only by being so enclosed, become part of the cosmic system.

Local, moment- and direction-signs renounce all claim to being " content," and endow the world with colour, scent and sound. It is entirely due to them that an orderly construction of the world is possible; and for that reason they may be called the elementary organisers of the world. None of them ever alters in magnitude and intensity; and so they furnish us with, as it were, a stable currency, which makes the world secure.

This unchanging, stable currency is the ideal denominator, employed in every calculation concerned with measuring the world, whether as regards space or time.

It will make things clearer for us if, when we consider the three qualities as elements of the mind, we employ a different terminology from what we use when they are considered as world-factors. We have already contrasted the place, as the smallest indivisible world-factor, with the local sign as the mental element; in the same way we contrast the moment with the moment-sign. It is only when we come to the direction-sign that we find ourselves in a difficulty, because the word "direction" does not contain the idea of a very small entity. But since a series of direction-signs signifies a definite progression in one direction, we can set each direction-sign parallel with a step, and speak of direction-steps.

It is only close at hand that we are made aware of direction-steps in the dimension of depth by means of direction-signs; for greater distance we must make use of other aids, such as distance-signs. Therefore it is appropriate in such a case to speak of distance-steps.

Accordingly we shall describe moment, place and step as the three factors of the cosmic order, to which in calculation we must have recourse as the final, indivisible elements.

Since no one world is applicable generally, the three world-factors have no universal value, but are restricted to the special world of each subject; and they must not be applied directly from the world of one subject to that of another.

In order to make things more intelligible, we have made a kind of compromise, and have chosen certain measurements of time and length, which we all employ in our own world as so-called objective measurements. If we are trying to get a real insight into the worlds of other subjects, we must each of us refer to these standard measurements the particular world factors by which we measure things in our own world.

THE INFLUENCE OF ABSOLUTE WORLD-MEASUREMENTS ON OUR EXISTENCE

It is suggestive that, as the number of places in the world increases, so also does the size of the objects surrounding us, and their details correspondingly multiply. In such a case, the whole world seems to expand on all sides and become fuller. Weget some notion of this by looking through a magnifying-glass.

CHAPTER III
THE CONTENT-QUALITIES

THE POINT OF VIEW OF PHYSICS AND OF BIOLOGY

According to the physicist, there is only one real world; and this is not a world of appearance, but a world having its own absolute laws, which are independent of all subjective influence. The world of thephysicist consists (1) of places, the number of which is infinite, (2) of movements, the extent of which is unlimited, and (3) of moments, having a series without beginning or end! All other properties of things are referable to changes of place by the atoms.

The biologist, on the other hand, maintains that there are as many worlds as there are subjects, and that all these worlds are worlds ofappearance, which are intelligible only in connection with thesubjects. The subjective world consists (1) of places, the number of which is finite, (2) of movements, the extent of which is limited, (3) of moments, in a series that has both a beginning and an end, and (4) of content-qualities, which are also fixed in number, and have laws which are likewise laws of Nature.

To the eye of the uninstructed man, all that is visible is his own world of appearances, enveloped in space and time, and filled with the things of sound and scent and colour.
Scientific investigation attempts to influence this simple way of regarding the world, and from two opposite quarters.

Physical theory tries to convince the plain man that the world he sees is full of subjective illusions, and that the only real world is much poorer, since it consists of one vast, perpetual whirl of atoms controlled by causality alone. On the other hand, the biologist tries to make the plain man realise that he sees far too little, and that the real world is much richer than he suspects, because around each living being an appearance world of its own lies spread, which, in its main features, resembles his world, but nevertheless displays so much variation therefrom that he may dedicate his whole life to the study of these other worlds without ever seeing the end of his task.

The laws connecting each subject with his appearance world cannot be compassed by causality alone, but must be explained as conformity with plan. The distinguishing sign of this plan resident in every created thing, isolated within itself though it appears, finds expression in the saying, "All for each and each for all."
Consequently, in considering a whole that is based onplan, it is immaterial where we begin. AUthings within it must react on one another. So we may begin either by studying subjects, or by investigating their appearance-worlds. The one could not exist without the other.

Now as soon as we have studied even a few animals long enough to show what is the world of appearance that surrounds them like a firm though invisible house of glass, we are enabled to fill the world around ourselves with a countless multitude of these iridescent worlds; and this a thousandfold enriches our own, however full and varied it may be. And thus it is that biology can offer the plain man an unlimited enlargement of his world, whereas the physicist would reduce him to beggary.

THE FORM OF THE QUALITY-CIRCLES

A preliminary condition for the investigation of the appearance-worlds of others is an exact knowledge of our own.

MARK-SIGNS

Interpreted in this way, the mark-sign means the alteration in the content that is just perceptible to the attention.

The number of mark-signs for colour increases with the skill of the individual observer in distinguishing colours; it gives us a clue to the amount of colour in his appearance world. From careful investigation, we know that the world of the colour-blind is ever so muchpoorer than our own.

While the person with normal sight can make, by means of certain artifices, some representation of the colourless world, the colour-blind is quite incapable of imagining the coloured world of the normal eye. Just as little can the unmusical man conjure up the world of melody in which lives the man who has a musical sense.

We can distinguish two kinds of mark-signs—those for qualitative differences and those for differences of intensity.
The former are always associated with a definite quality.

THE INDICATIONS

In constructing the world, mental sensations become properties of things; or, in other words, the subjective qualities build up the objective world.

If we put the mark-sign in place of the sensation or subjective quality, we may say that the mark-signs of our attention become "indications" as to the world. Accordingly, the laws that are binding for the internal mark-signs must also hold good for the external indications. Immutable laws of this kind we call natural laws.

All the dicta of physics relate to indications of the world, and are based on the laws that fall to their share as mark-signs of our attention. The fact that, like the moments in time, the places in space cannot be interchanged nor the intervals between them altered, is put beyond all question merely because such relations depend on the form of our attention which precedes all experience. By means of this theory, Kant laid bare, for all to see, the very foundations of human knowledge.

When indications make their appearance in the world, they are already in the grip of these laws, and this without any reference to the objects with which they are associated.
As soon as indications appear in the world, caught, so to speak, by the bull's-eye lantern of our attention, the process of apperception sets in, and creates from them new structures, i.e. things, objects and implements.

Here we shall merely point out that each new formation appears as a unity, and then, in its turn, becomes an indication. Our world is filled with these indications, which we usually describe as objects ; but we must not forget that, one and all, objects are built up from the indication-material of our qualities.

THE OBSERVER AND THE WORLDS OF OTHERS

If an observer has before him an animal whose world he wishes to investigate, he must first and foremost realise that the indications that makeup the world of this other creature are his own, and do not originate from the mark-signs of the animal's subject, which he cannot know in the least. Consequently, these indications are, one and all, beneath thesway of the laws of our attention; and, as soon as our attention is directed to them, we cannot free them from these laws.

Since we are not in a position to investigate the appearance world of another subject, but only that part of our appearance world surrounding it, we had better speak of the surrounding-world of the animal. It is only for the observer himself that the surrounding-world and the appearance-world are identical.

The material from which the surrounding-world of another is built up, invariably consists of our own objectivated quality, for no other qualities are accessible to us. The only difference from our own surrounding-world is that the qualities are fewer in number.

We can divide up the surrounding-world of every other subject into two halves, as will be explained fully later on. The one contains those of the observer's indications that affect the animal as such; on that account, I call it the world-as-sensed. The other contains those of the observer's indications to which the animal reacts; this I call the world of action.

Let us assume that indication C in the figure on the preceding page represents the scent of honey, and the indication D its fluidity, then it is obvious that, if the animal is a bee, the indication C, which acts on the animal, lies in the world-as-sensed, whereas the indication "fluidity," which makes it possible for the bee to drink, lies in the world of action.
It is only in our own surrounding-world that honey, as a sweet-scented fluid, is fused into one unified object; in the surrounding-world of the bee this does not happen, for the indication fluidity does not act on the bee, but merely underlies the bee's behaviour.

THE OBSERVER AND THE ANIMAL

Theproperties of which the animal is composed are likewise indications for the observer. These, after careful study, he will divide into two halves—areceptor half, corresponding to the world-as-sensed, and an effector half, corresponding to the world of action. The receptor half receives the actions of the surrounding-world, and the effector half reacts thereto.

There is an astonishingly close correspondence, on the one hand, between the animal's receptor organs and the world-as-sensed and, on the other, between its effector organs and the world of action. This must strike every observer, and it gives the impression that the animal is merely an imprint of its surrounding-world. On this impression are based all the theories that see in the living substance of which all animal bodies are made, merely a plastic element, passively moulded, which adjusts itself more or less exactly to external influences.

These theories overlook one essential circumstance, namely, that the surrounding-world of an animal, if considered by itself, is not a unity. On the contrary, the properties of the surrounding-world become linked up into a unity only when they are in agreement with the properties of the animal; without this bond, they merely flutter about disconnectedly.

The most important advance, however, lies in the following conclusion. If the laws manifested in the forms of our attention (which is the deciding factor for the appearance-world of our own subject) can be recognised not only in the shape of our own body, but also in the shape of the bodies of other subjects of whose attention-forms we know nothing, then this indicates that the work of fashioning by the mark-signs is not determined purely by our own subject, but is super-subjective.

This means that we are on the track of a control by Nature pointing to a unity even higher than our own apperception, in which otherwise we must see the final unity.

The fact that the forms of our attention find expression in the conformation of our own frame is sufficient to suggest that there is a factor which uniformly determines the activity both of our consciousness and of our body. It is not enough to speak of a parallelism between mental and bodily processes; an expression like this loses its sense when we are dealing with a comparison between intensive and extensive forms, for such forms are never parallel to one another. On the other hand, we may speak of identical laws, which express themselves both in intensive and extensive forms.

THE TEMPORAL BOUNDARY OF THE SURROUNDING-WORLDS

If we represent the surrounding-world of an animal at any given moment as a circle, we can add on to it the succeeding moments, each as a new circle of the same kind. In this way we get a tube, which would correspond to the length of the animal's life. On all sides the tube is formed of indications, which we can imagine to be built along and around the life path of the animal. The life-path thus resembles a tunnel passing through the surrounding-world and closed at both ends. In this tunnel the nature of the indications that may appear is fixed from the beginning; so we may say that its extent and the variety it displays are predestined. Moreover, the time-length of the tunnel has a prescribed measurement, which cannot be exceeded.

Proceeding from these immutable factors that determine all life in the world, we come to see that life itself is based on fixed laws, which are in conformity with plan: these laws do not becomeapparent, simply because the individual destinies are so numerous that we are unable to appreciate the influences they exert on one another. As a matter of fact, however, they are merely variations on a set theme, and a limit can be set to the possibilities they present.

SUMMARY

To space and time, the forms of our knowledge which are present before all experience, we have to add the forms of the content-qualities, which cannot be intuited directly. As we have seen, they can be brought nearer to intuition by transference into spatial relations, as has already been done in the case of time, of which our extensive experience is direct.

On this point, therefore, we must expand Kant's doctrine, and show that for all kinds of qualities there are forms which are present entirely a priori and precedent to all experience; and these appoint to each quality, as soon as it appears, a fixed position in a system.

The neglect of the a priori forms of the content-qualities is partly referable to their having no names of their own, such as space and time have. The only familiar term has been the metaphorical "musical scale" for the form of sounds, and, using that as a basis, we also speak of a "scale of colour," a "scale of smell," etc. The use of the word "scale," or ladder, for the form of the content-qualities was the first attempt to make these forms accessible to intuition, and accordingly it deserves to be retained as the general designation.

In yet another point we are obliged to expand Kant's doctrine. Not only are there fixed forms for each quality material, but the number of individual qualities within their form is also absolute, and precedent to all experience.

Even if the absolute number of qualities changes with each subject, and the determination of the number in individual cases is left to psychology—or shall we say, to biology?—(it is not at all necessary that the particular subject should actually experience all the qualities present in its forms), nevertheless the law that the number of qualities present is absolute is a law of the pure theory of knowledge.

Since knowledge of the other subject's "mark-signs" is denied us also, we are confined to determining what properties of our appearance-world have value as "indications" in the surrounding-world of an animal. These indications (which must become mark-signs for us, if we are to experience anything of them at all), we shall treat like our own qualities, so far as possible, and arrange them in the forms given us a priori.

We see a justification for this proceeding in the fact that the anatomical structure of the sense-organs of animals brings together as a unity those indications that our attention also treats as a unified quality-circle. Nevertheless, we should never forget that, so long as we are concerned with biology, we must not for an instant desert our posts as observers from the outside.

CHAPTER IV
OBJECT AND LIVING ORGANISM

THE BIOLOGICAL ELEMENTS

Through it we have become acquainted with the ultimate biological elements, the qualities. We have learnt to distinguish between order-qualities and content-qualities. Further, we have seen how the three order-qualities—moment-signs, local-signs and direction-signs—as soon as they combine with any of the content qualities from any particular sense-circle, become converted into moments, places and direction-steps; and these are the organisers of the world.

Finally, we know that all qualities are the material of a particular form. The form of the moments is time, the form of the place is the extended, the form of the direction-step is motion. Motion, by means of the planes of direction, becomes space, which is enclosed on all sides by the extended.

THE CONTINUITY OF THE WORLD-PICTURE

Thepopular, physical way of looking at the world, which assumes the actual existence of objects, accepts unreflectingly certain axioms which assuredly cannot be arrived at from experience of objects, but are derived solely from the organisation of our mind, for that lies at the basis of every experience. Chief among these axioms is the theory of the continuity of the world, which contrasts so strikingly with the fragmentary character of our individual experiences.

The principle of the continuity of the world takes its origin, in part, from Kant's theory of the forms of experience. The forms space, time and motion are, in their very nature, continuous andquite independent of the individual experience, which is always discontinuous. It is interesting, however, to show how insingle instances the gaps become closed up by the forms.

I have already drawn attention to the gap that must appear in the world-picture on account of the blind spot in our retina, but which gets filled in by the coloured surfaces of the environment immediately growing together.
Still more obvious is the break in the series of our moment signs which comes with sleep: it is filled in by the pure form of time.

The example of gravity shows that it is not possible to deduce the continuity of the world-picture from motion alone, as a form of experience, which is what the physicists often try to do. We see that this continuity arises from a more widely embracing law of our experience-activity, which, following Kant, we call the law of cause and effect, or "causality."

It is only this major premiss, valid for all human experience, that produces the ultimate continuity of the world-picture, by compelling us to inquire into the cause and effect of every phenomenon.

Space, time and causality guarantee the continuity of the world-picture, but they in no way guarantee its completeness.
For the attainment of completeness, the forms of the content qualities (the musical scale, the scale of smell, etc.) must first be taken into account.

But even then, completeness is not attained. For an essential property of the world-picture, deliberately overlooked by the physicists, is still lacking—i.e. grouping into unities. Separation into spatial atomic systems will not meet the case. Our world-picture is filled with unities.

THE SCHEMA

It is through Kant that we have learnt sufficient self-knowledge to inquire into the subjective factors; and this question, since we have become convinced of the subjective nature of the world, has come to seem the most important of all.

Analogous relations arise when we run our eye over contours, and the sequences of direction-signs determined thereby impress themselves on us as a melody would. The repetition of this melody takes place so quickly that we are not conscious of the individual direction-signs. Before it is played, the melody itself is quite unknown to us. Only the result is known to us, and it appears in such a form that we realise the presence of a something familiar.

In this process, the melody of the direction-signs does the shaping, but all we are conscious of is the "shape." Kant called the form-giving melody a
"schema," and the art of shaping, which lies hidden in our mind, he called "schematisation."
Following Plato here, Kant compares the schema of empirical things with a kind of monogram, which has stamped itself on our mind, and forms the starting-point both for shaping things and for drawing images in the imagination.

We may conclude from all this that, in order to form things, we make use, voluntarily or involuntarily, of a mental process; but of this process, although it is formed by ourselves, we know nothing. The process employs local signs as well as time-signs and content-signs, but depends in the main on the seriation of direction-signs. Since it surges up from the complete unconscious, nothing more exact can be stated regarding it; and we must agree that Kant was right when he said that it is "an art hidden in the depths of the human soul, the clue to which we occasionally and with difficulty wrest from Nature, and shall make manifest."

Our whole memory is like the rigging-loft of a theatre with wings filled with schemata, which from time to time appear on the stage of our consciousness, not in their own character, but dressed up in the content-qualities of our mind.

THING AND OBJECT

Qualities and schemata together compose the things of the outer world, as we see them displayed before us. We say that things have such and such properties, and if everything remained in a state of repose, this would be a complete statement concerning the world. But everything in the world is subject to movement and change, and all things react on one another reciprocally.

When we wish to embrace the sum-total of the properties and capacities of a thing, we speak of an object. The possession of capacities characterises the object as contrasted with the thing. The distinction is important, because, through its capacities, an object reveals the whole of its reciprocal action with other objects.

Now a fixed subjective rule underlies this collective reciprocal interaction of objects; this rule is the so-called law of cause and effect, or causality.

The object as such is not visible, because it has extension in time. We may also call it a thing expanded by a moment sign; and, by the use of this expression, its capacities are revealed as new or altered properties. The fixed relations that altered properties bear to the same unity are created by the rule of causality, which makes the alteration appear as the necessary effect of external causes. So the object constitutes a higher unity than the thing, thanks to the law of causality, which likewise is an outward manifestation of our apperceptive process.

Causality compels us to seek for a cause for every change in the moment that hasjust gone, and for an effect in the moment that follows. It iscausality which, throughout the ages, throws a bond around aU world phenomena.

It is not surprising that physics should attempt to explain all associations in the world by causality alone, rejecting any other way of considering them. And yet physics is wrong, for causality is not the only rule at our disposal for systematising the world.

MATTER

We call the content of objects, matter. Like the object, matter has properties and capacities. The science concerned with the investigation of matter is chemistry. Matter is not freely exposed anywhere; in order to get matter, we must always first destroy an object. This is most obvious when we wish toget matter from some implement that we have constructed ourselves. To do so, we must destroy not only the external form, but likewise its internal structure.

Let us assume, for instance, that we break up an old locomotive to get iron from it. We then discover that, in addition to the conformation of the parts from which the locomotive is built, there is another which belongs, not to the locomotive, but to the iron itself. In order to keep this distinction clear in words, we shall call the "framework" the disposition of the parts in space, in so far as that belongs to the locomotive; and the arrangement of the iron particles inspace we shall call the "structure."

The confusion of these two essentially different kinds of conformation has led to serious error; and still at the present day it misleads many scientists so far, that they even derive the framework of the living organism from the structure of matter.

The mediaeval chemist looked at a substance, touched it, smelt it, tested its sound and tasted it. Then he noted down all the properties observed, and from these data he described the substance as exactly as possible, in order to distinguish it from others. Very early the theory of the four elements was established.
But the knowledge that every substance has three states of aggregation controlled by heat was no more than a vague presentiment lying at the basis of this theory.

Theunreliability of the tests, and especially of those for the intensities of the several qualities, led gradually to the introduction of other properties admitting of more certain determination. Thus, in order to get away from direct testing of heat, use was made of the expansion of bodies, and the thermometer was invented. To measure weight, the movement of the balance was employed, and that fixed the standard.
To test hardness, a series of special substances was chosen, each of which would just scratch the others.

Thus by imperceptible degrees the whole study passed from the domain of the other sense-organs to that of the eye.
All our apparatus has reference to the eye, and especially since in chemistry the testing by sound has fallen more and more into disuse.

The ideal now is to refer all the qualities of substances to the arrangement and movement of atoms or groups of atoms. As a final outcome of this theory, the atom loses every material character whatsoever, and becomes a mathematical point in an eddy of a medium that is continuous and universally circulating, but not further defined.
And with that we get back again to pure local signs and direction-signs.

From the biological point of view nothing could be said against this reduction, if physics recognised clearly that, in the last instance, it builds its foundations upon purely subjective qualities, and that consequently all the structures arising thereon are purely subjective appearances. But this is by no means the case, for physics is all the time under the delusion that, through its reduction of all properties and capacities of substances, it is continually getting nearer to the true reality.

The substitution of local signs and direction-signs for the content-signs does not mean that these disappear from the world. What one has done is tobring in a common denominator, of general application, which alone permits of working by calculation ; and this has been the real aim in view throughout the whole development of chemistry.

OBJECT AND IMPLEMENT

If we are to put in the proper light the question at issue between physics and biology, we must use very clear-cut terms. Physics maintains that the things of Nature around us obey causality alone. We have called such causally ordered things, "objects." In contrast to this, biology declares that, in addition to causality, there is a second, subjective rule whereby we systematise objects: this is conformity with plan, and it is necessary if the world-picture is to be complete.

When the hammer strikes the string of a piano and a note sounds, that is a purely causal series. If this note belongs to a melody, it is interpolated in a sound-series, which also exhibits arrangement, but not of a causal kind.

When the carpenter's axe chops up the wood into planks and pegs, and when the drill bores through the planks and the hammer drives the pegs into the holes, these are all of them in causal succession. But the structure emerging from this process, the ladder, cannot be interpreted by causality; it can be understood only from a knowledge of the designed arrangement of the rungs with relation to the main planks, and of all the parts to the whole.

We shall call "implements" those objects the construction of which is not to be explained by mere causaUty, since in them the parts stand in the same relation to the whole as the individual sounds do to the melody.

Both objects and implements consist of matter; but in the object there is no arrangement of the parts other than that which the structure of the substancebrings with it. In the implement, there is, in addition, a framework which connects up the parts into a whole that expresses plan.

In outward appearance, objects and implements are indistinguishable from one another. The same local signs and content-signs, enclosed by the same schema, form them both; just as the words of a language present the same optical appearance to the man who knows the language as they do to the foreigner. But the one knows the laws determining the juxtaposition of the letters in the word, while the other, not having this guide, stares uncomprehendingly at the words of the foreign tongue. The one sees before him only various assemblages of letters; the other reads words.

The fixed rule of the action of climbing at once brought order into the confused medley of sticks and holes, and formed the ladder. It is only the knowledge of the rule of action pertaining to its "function" that arranges the parts into the whole. If we do not know the function, which establishes fixed relations, we cannot know the design, and we do not recognise the significance of the implement. Accordingly, instead of the plan expressed by an implement, we may speak of its "functionality."

THE LIVING ORGANISM

The framework of our human implements is intelligible chiefly because they all refer to some very familiar human function. The actions of implements are never their own actions, but are merely counter-actions to our human doings, which in some way or other they support, refine or expand.

Morphology. This certainty that a principal function forms the scaffolding around which the other functions group themselves, is lacking when we deal with living beings, and we very soon feel the effects. As a matter of fact, a new science, "morphology," has developed from the mere description of the framework of organisms, a science which, in contrast to the theory of function, is not applicable to our human implements.

At avery early date the conviction forced itself on zoologists that a classification of animals must be carried out not according to functional, but according to morphological features; not the "analogy" of the anatomical parts, but their "homology," is to be the standard for classification.

And thus greater importance is ascribed to the position of the organs in the animal body than to their function. If we were to try to classify our tools in the same sort of way, the result would be sheer nonsense. On this ground alone a mechanistic theory of living things should be rejected.

It is not questioned that the rules of morphology relate to the framework, and never to the material. We may say that the framework of implements is judged from the point of view of function, hut the framework of organisms both from the functional and from the morphological. Of this, the recognition of the two principles of analogy and homology takes full account.

Discovery of the morphological principles in the architectural plan of the animal is made possible by comparison.
For if we consider the architectural plan of an individual animal taken by itself, all we shall be able to recognise at the first glance are functional principles.

This fact finds expression in our saying that morphology also means "comparative anatomy." Striking though the fact is, it was at one time taken quite as a matter of course, without anyone seeking for the explanation that lay so near at hand. It was reserved for Darwinism to assert that the morphological principles are referable to the physiological principles of earlier generations.

As a tangible proof of this very dubious theory, Darwinism discovered the "vestigial organs" said to be demonstrable in every individual now living as surviving remains of physiological requirements in past ages.

When, for instance, we find that the whale and the giraffe, which are both mammals, have the same number of cervical vertebrae, namely 7 (and this despite the extremely different length of their necks), but that the swan has more than 20, then morphology is completely justified in claiming to use its rules as indications for the determination of relationship. But the nature of the connection between relationship and homology, as regards the position as well as the number of organs, remains quite problematical.

Onething, however, must be maintained. The existence of a morphological science of living organisms is not just a matter of course; it is an exceedingly puzzling fact, which cannot be deduced from analogy with non-living implements.

Physiology. If by physiology we understand the study of the functions of living things, then its chief task consists in the functional analysis of the framework of organisms. In making this analysis, it becomes evident that the structure of the substance of which living beings are composed passes over into the framework in such a way that we can never make certain just where the one begins and the other ends.

If the protoplasm be left out of account, it can be said of the framework of the cell that it is an absolutely perfect machine (in contrast to our machines, which are always only approximately perfect), for no property of matter is present which does not enter completely into the framework; moreover, the rules which hold good for the construction of this micro-machine are exclusively functional. This is in marked contrast to the arrangement of the organs, which is determined by morphological rules as well. Whether we consider muscle-cells, nerve-cells, bone-cells or sensory cells—in each and every instance we find the same perfection.

In this respect, there is no such thing as evolution; the lowest, just like the highest of living creatures, are, as regards their micromechanics and microchemistry, equally perfect. In face of this fact, all attempt to explain living things as chance agglomerations of substances collapses utterly.

An organ constructed for a narrowly restricted function is not, on that account, more perfect or less perfect than one that serves several functions. The foot of a fowl is neither better nor worse than the foot of a duck, although the duck's foot serves for progression in the water as well as on the dry land.

The inferiority of an organ in one individual when compared with the same organ in another of the same kind is a matter for pathology, and has nothing to do with evolution.

In spite of our dissent from the doctrine of evolution, it would be childish to deny that there are higher and lower organisms. But we must confine ourselves to showing that there are animals with more numerous, if not necessarily better organs; and these we call "higher" animals because they are so rich in organs and in functions.

The organs of animals are always the perfect expression of one function or of several, and consequently changes that take place in them point to a change of function. The functions themselves, however, are always unities, and not subject to change. One function, it is true, may more or less force another into the background or even cause it to disappear altogether; but functions themselves do not change.

SCHEMA AND FUNCTION

The case of deaf-mutes gives us a good idea of what our complete helplessness would be if we were deprived of the sense-control of our actions. We should actually be incapable of initiating even the least regulated sequence of movements.

In the case of animals it is not possible to make this statement. There are animals that execute quite definite movement-sequences, in which control by the sense-organs is lacking. Actions of this kind can come about through a special kind of nerve-linking; they are called reflexes. When, on the other hand, regulated movement-sequences are performed by an animal that is without control by sense-organs, and such movements are not linked together and conditioned by any demonstrable structure, we speak of instinctive actions.

The difference between animals that learn through experience, such as human beings, and instinctive animals like birds and insects, depends mainly on the latter having for their functions inborn impulse-sequences which proceed faultlessly without any further control. Intelligent animals require schemata in order to form the correct functions and maintain these by their control.

Before every single action, even in the case of a human being, the impulse-sequence for the function must be there ready and prepared. When this begins to come into play, the controlling schema strikes up along with it and at the same rate, and so brings the functioning to our consciousness. We are informed of every deviation from the normal function.

Since in ourselves the functions undoubtedly have to be learnt, we are apt to assume that they must somehow have fixed themselves in the framework of the nervous connections in the brain. And this might be the reason why we are not conscious of them.

This is an open question. It is of considerable importance, because the answer to it means neither more nor less than the recognition of non-physical natural factors in the working of the body.

I may admit that the entire world is appearance, and that the things in it are composed of my sense-signs + schemata, andyet this does not force me to assume that the forms of movement observed in the world are directed by anything but causality and the conformity with plan that resides in the framework of implements. I am obliged, then, to assume also that the impulse-sequences are in some way or other laid down in the brain by nervous structure.
This way of regarding the world reduces man to a machine, endowed by chance with consciousness, while all other animals are able to get along quite well without it.

Instinct would find no place either, and, in spite of the non-demonstrable nervous organisation, would have to be interpreted as a highly complicated reflex action.

THE FRAMEWORK

It is a remarkable fact that, while the assertion that a machine may be regarded as living organism excites general contradiction, the opposite assertion, i.e. that we may compare living beings with machines, finds many supporters.
The contradiction in this becomes less obvious if we express the two statements in another way. From the statement "machines have theproperties of the living," we shall at once dissent; on the other hand, the statement "living beings have mechanical properties" is certain to meet with general agreement.

It sounds positively ridiculous to maintain that a locomotive with an optical apparatus is a kind of horse; but to compare a horse with a locomotive is very tempting.

It has been shown that this method of analysis of an organism offers very considerable advantages. Indeed, comparative physiology maintains that we should consider every animal as a bundle of reflexes, work out each single reflex-arc thoroughly, and then study their common central connection. Only by this method can we succeed in demonstrating completely the mechanical properties undoubtedly present in the organism; and this exceedingly important science we call physiology.
But every biologist must see that this does not complete the work of investigation, for a bundle of reflexes is not an animal, even if we bring into relation with its structure all the chemical actions of the body, organised, as they are, in full conformity with plan.

In addition to mechanical, a living being also possesses super-mechanical capacities, giving it a character which would still be quite unlike that of a machine, even if the parts of the machine were constructed with the same perfection as are organs, and even if their counter-actions were real actions, i.e. were not referable to the action of a human being.
The super-mechanical powers of all organisms consist in this, that they include the activities exercised on machines by human beings. They make the machine of their own bodies themselves, they run it themselves, and they undertake all its repairs.

All three of these super-mechanical powers—the construction, the running of the machine, and its repair—appear to be boundup with the existence of protoplasm, which machines do not possess. Every living thing proceeds from protoplasm; traces of it remain in every cell, where it forms that part of the cell which does not pass over into the mechanical framework of the whole. And the protoplasm as a whole is kept in continuity throughout the body by means of fine connecting strands.

When this separation is made, we realise that an organism without its protoplasm represents an ideal machine. This skilfully interwoven bundle of reflex-arcs, with its perfectly constructed receptors and effectors, has become an independent machine, responding to the influences of the outer world by means of its own actions. But these actions are quite unalterable and automatic, and it is here that we see demonstrated the most essential contrast between what is living and what is dead. If, in virtue of its framework, a creature behaved physiologically like a living organism, but nevertheless was without protoplasm, we should be obliged to describe it as dead.

PROTOPLASM

Protoplasm, as it is found in all living cells from the germ cell onwards, also possesses a mechanical framework, for it exhibits the fundamental mechanical actions of the living organism; it is capable of movement, metabolism, ingestion of food and so on. One of the chief things it does, i.e. cell-division, requires, indeed, a very complicated mechanism.
If this were all that we might expect of protoplasm, then we should have in it nothing more than another machine incorporated in the large one.

But fortunately, Nature, when she created the unicellular animals, such as amoebae and infusorians, which consist, entirely or in main part, of protoplasm, has vouchsafed us a glimpse into its super-mechanical powers. Study of amoebae has taught us two things—first, that in order to carry out a mechanical action, a mechanical apparatus must be present:
and second, that protoplasm has the power to go on creating the mechanical apparatus anew and to break it up again.

There is, then, a non-material order which first gives to matter its framework—a rule of life. This ruleappears only when it is creating the framework; and this it forms on strictly individual lines, corresponding to the material properties of the protoplasmic animal concerned.
It is like a melody, which controls the sequence of sound and the rhythm in accordance with law, but becomes apparent only as it becomes operative, and then takes on the tone colour which the properties of the particular instruments impose on it.

These are simple and obvious facts, and in no way nebulous theories. And they give us the key to the three above mentioned actions of protoplasm in the higher animals—construction, running of the machine, and repair. In all cases, something new is achieved; but in accordance with an already existing rule, and always with special relation to the properties of the organs. There is never evolution, but always epigenesis.

SUMMARY

In this chapter, devoted to synthesis, we have seen how, by the help of schemata, the things of space take on material form; how, by the help of causality, objects, extended in time, are comprehended as unities; and how, by the help of conformity with plan, implements arise. Furthermore, we have investigated conformity with plan, and we have found that it is always based upon a function. By tracing back our own actions, we have referred function itself to the impulse sequence, which comes to our consciousness indirectly through our own qualities.

CHAPTER V
THE WORLD OF LIVING ORGANISMS

Every animal is a subject, which, in virtue of the structure peculiar to it, selects stimuli from the general influences of the outer world, and to these it responds in a certain way.

These responses, in their turn, consist of certain effects on the outer world, and these again influence the stimuli. In this way there arises a self-contained periodic cycle, which we may call the function-circle of the animal.

The sum of the stimuli affecting an animal forms a world in itself. The stimuli, considered in connection with the function-circle as a whole, form certain indications, which enable the animal to guide its movements, much as the signs at sea enable the sailor to steer his ship. I call the sum of the indications the world-as-sensed.

The animal itself, by the very fact of exercising such direction, creates a world for itself, which I shall call the inner world.

The actions directed by the animal towards the outer world produce the third world, the world of action.

World of action and world-as-sensed together make a comprehensive whole, which I call the surrounding-world.

The entire function-circle formed from inner world and surrounding-world (the latter divisible into world of action and world-as-sensed) constitutes a whole which is built in conformity with plan, for each part belongs to the others, and nothing is left over to chance.

If this circle is interrupted at any point whatsoever, the existence of the animal is imperilled.

It is not possible to write the biology of an animal unless one has first studied its function-circle fromevery side.
However different they may be, all parts of it are equally important. When we go on to study the various parts in detail, this continuity of the complete whole must never be lost sight of.

THE FUNCTION-CIRCLES

Just as we broke up the function-circle into sectors, so we proceed to divide up the totality of function-circles into separate circles or circle-groups, which, biologically considered, are absolutely distinct from one another.

The first is the circle of the medium. This circle is characterised by the fact that the medium itself exerts no stimulus on the animal; while on the other hand, if the animal forsakes the medium, a stimulus is immediately released, which results in the animal's being guided back into it. Accordingly, the medium is so constituted that in itself it possesses no indications on which the animal can seize; the water does not influence the fish, but the air does as soon as the fish comes to the surface. Conversely, for the animal living in the air, the water is a stimulus, but the air is not.

The ground and all fixed bodies always constitute obstructions in the medium, and consequently act as indications. So most animals are furnished withorgans of locomotion for getting over these obstacles, while only a small proportion have organs serving for movement in the free media of air or water.

In many cases, the medium is spatially restricted by special indications which fix the animal to a definite habitat.
Thus for gastropods and crustaceans, and also for insects, dark and light surfaces give signs which influence them in their course.

In addition to the function-circle of the medium, we can distinguish the function-circles of food and of the enemy.
In both cases, the animal receives a stimulus proceeding from the indications of the food (be it of animal or vegetable nature), or from those of the enemy, which latter is always, with almost negligible exceptions, an animal.

Following on the food stimulus, movement is turned in the direction of the food, and then, when contact is established, fresh indications, tactile or chemical, come in, which seem to guide the masticatory apparatus. At this point a number of circles often appear, which belong to the food circle.

Following on the enemy stimulus, the organs of locomotion are directed to lead the animal away from the enemy, or else the organs of defence are directed to drive it away. In both cases the enemy indications disappear.

As a fourth function-circle there is the sexual, which in principle is like the food-circle, only that what is set in activity by the animal's "control" is not the feeding apparatus, but the apparatus of sex.

All the circles, however far they lie separated from one another in the world-as-sensed, intersect in the steering apparatus of the inner world, and then separate from one another again in the world of action.

Biological treatment of the function-circles requires that we also consider from the point of view of conformity with plan that part of the circle which goes on outside the body in the surrounding-world. We are accustomed to treat things lying outside the subject according to the rules of causality alone. But by so doing we are not taking account of the biological framework, which is co-extensive with the whole circle.

Now animals are so much part and parcel of Nature that even the surrounding-world works within the whole like a part constructed in conformity with plan. We may assume that where there is a foot, there is also a path; where there is a mouth, there is also food; where there is a weapon, there is also an enemy.

This last instance expresses a fact often misunderstood, namely, that struggle belongs to the universal plan. In opposition to what the Darwinian theory assumes, the struggle for existence is not merely one cause in the causal series, but an essential part of the general plan of life.

It is not only the creatures with weapons, but also the defenceless ones, that are involved in the struggle. Their protection lies either in their swiftness or in their numbers.
The most striking instance of this is that many more eggs are laid than young are hatched, because the great proportion of eggs are always sacrificed to enemies. Here we see clearly that a new sort of conformity with plan comes in, which hitherto we have not considered; this is conformity with plan on the part of the species, of which we shall have more to say later on. But first we must confine ourselves with conformity with plan on the part of the individual.

One thing has become evident from our treatment of the problem up to this point, i.e. that biology is concerned only with conformity with plan, and that the study of causality comes into the question only in so far as it contributes to that investigation. All the things that play a part in the function circle of an animal we consider only from the point of view of function. This means that we have to do exclusively with implements, and never with objects.

The stone that a beetle climbs over is merely a beetle-path, and does not in any way belong to the science of mineralogy. Its weight and its material properties, such as atomic weight or chemical valency, are for us matters of indifference. These are all of them accompanying properties, which we may overlook, since we are interested only in the leading properties of the form and hardness of the stone.

Now since conformity with plan is the supreme law, not only for material things but also for the processes of the mind (of which apperception is the direct expression), many investigators are inclined to transfer from physiology to psychology, and from the body to the mind of the animal, the guidance according to plan which constitutes the main activity of the inner world.

There is one essential objection to this, and it is that we are trying to treat the whole function-world of the animal under investigation as our own experience, and not as the experience of the animal They are our indications which are affecting the animal. It is we who observe the guidance given. It is our apperception which recognises the plan.

If we tried to change the point of view suddenly and look at things from the animal's mind, we should lose the interconnection of the appearances on which for us it primarily depends. We should suddenly find ourselves surrounded by the animal's appearances, which have no connection with our own. For the unity of appearances depends solely on the unity of our own apperception.

THE WORLD-AS-SENSED

STIMULUS—INDICATION—QUALITY

From the examples quoted, it must be clear that stimulus and indication are not identical concepts, although they are applied to the same qualities.
Only if we bear in mind wherein the three modes of investigation—i.e. the physiological, the biological, and the psychological—differ from one another, shall we understand how to apply these three elementary concepts correctly in each case.

In the process of investigation, the physiologist and the biologist take up the same attitude, for they consider themselves as observers external to what they observe. They have before them an object and an animal; they both study the influence which the object exerts on the animal.

But the physiologist investigates the causal connection, and the biologist its conformity with plan. As a consequence, the physiologist follows, on its path through space, the effect proceeding from the object. In studying an animal, he will trace the air-waves to the ear, and there observe their transformation into nervous excitation; in like manner, he will follow a light-ray as an etheric wave to the eye, investigate its refraction by the optical media, note the production of images on the retina, and discover the chemical transformation into nervous excitation that takes place in the rods and cones.

In the course of this study it becomes evident that, outside the animal under observation, numerous influences proceed from theobject that are not taken up, because a certain intensity of the external influence is required if a nerve is to be excited. Physical and chemical processes in the outer world must exceed a certain threshold if they are to act as stimuli affecting the nervous system of the animal.

This threshold can be raised or lowered by special means in the animal's nervous system. Moreover, by their anatomical structure, the receptors are obliged to admit only those stimuli that are suitable for them.

By the structure of its receptors, every animal is cut off from a great number of physical and chemical influences coming from the outer world, and it is only through stimuli that the outer worldgets in touch with the nervous system.
If we take the anatomical structure of the receptors as given, this whole process can be investigated by purely physical and chemical methods, and that is just what physiology has to do.

When an animal meets with different scimuli, the physiologist will be inclined to assume that these make different impressions on the animal, and provoke it to different responses. Likewise he will assume that the same stimulus makes the same impression on the animal, and calls forth the same response.
Neither of these assumptions is correct.

For the biological study of an animal, therefore, knowledge of the stimuli is not enough. Yet another factor must be sought in order to explain why the animal should give the same response. I shall call this factor an indication.
The indication is not a physiological factor like the stimulus, but a biological factor which we deduce from the animal's response. It cannot, however, be constructed from the stimuli alone, because its formation depends on the animal itself, and because it cannot be understood at all without knowledge of the means that the animal employs for that formation.

It is not possible even for the biologist to transfer the event observed by him (as in the case of an animal influenced by an external object) outside the frame created by his own subjectivity. He is always dealing with events that take place in his space and in his time and with his qualities.

If we consider the process, such as an implement influencing an animal in the direction its movement takes, we must first and foremost analyse the implement by breaking it up into its properties and looking for its rule of function, so as to decide which of the properties serves the animal as indication, or whether a function-rule belonging to the animal itself is employed in that way. Thus our research is everywhere limited by our own qualities and capacities.

We can indeed show that Paramecium does not use a function-rule as indication, and hence has no implements in its sensed-world. We can show that it does not use outlines as indications, and so has neither objects nor material things in its sensed-world. Further, we can show that the most diverse properties, which for us form very different qualities, fuse into one single indication : but what qualities this forms in the mind of Paramecium passes our comprehension. As biologists we can avoid these unanswerable questions, since our inquiry is not directed towards the content of the various qualities or mark-signs, but only towards their employment as indications.

This task devolving on the indications is clearly distinguishable from that of the stimuli and of the qualities, and thus assumes a central position in biology, which makes it necessary for us to discuss in detail the theory of indications.

THE THEORY OF INDICATIONS (INDICES)

The starting-point for an understanding of every theory of indications is the fact that every impression an animal experiences is both fundamentally like and fundamentally unlike all other impressions. This seemingly very contradictory fact is based on the following arrangement, which is a fundamental one for all animals.

From which we perceive that the number of indications and their composition are the business of the organisation of the animal subject.

In animals that are little centralised, such as the sea-urchin, the mark-organs embrace without distinction the localised nerves lying alongside one another; in such a case, the indications are separated from one another only by space.
In the higher animals, with highly developed sense-organs, the organs for the indications receive nerves, the local grouping of which retains its specific irritability. In such cases, the indications differ from one another as regards content.

Now in the great majority of cases we are in complete ignorance concerning the mark-organs of animals, and are compelled to deduce these from the indications to which the animals react. The indications that we study in this way are equipped with our human qualities, and there is nothing for us to do but to use them just as they are. But we shall fall into the crudest sort of error if we have not learnt to analyse the objects that we observe in their effect on animals so thoroughly that we are in a position to treat the qualities as independent factors.

All implements in the world are really nothing but human indications. If we want to study those of animals, we must know the fundamental factors of which the human ones are composed, and by what rules this composition takes place.
Anything else is sheer amateurishness.

THE HIGHER GRADES OF THE WORLDS-AS-SENSED

As has already been pointed out, it is not at all necessary that the indications of an animal should reach the same height in each of its function-circles. As a rule, in the enemy-circle a mere movement will serve, whereas in the prey-circle even the outlines may have this value. The disputes between investigators hitherto depend on this difference, some maintaining that colours exist in the sensed-world of the lower animals, and others saying that they do not.

The world-as-sensed undergoes an important enlargement when indications appear for the movements of the animal's own limbs. It is only among vertebrates that sensory nerves have been demonstrated with certainty in the muscles. And it is only when nerves of this kind appear that we can speak of a new function-circle, passing through the animal's own body.

From experiments on vertebrates in which the sensory roots of the spinal cord have been severed, we know something about this function-circle. There can be no doubt that it is only when the animal's own body in movement becomes an indication that a sharp line can be drawn in the world-as-sensed between the subject and the outside world.

The highest grade of world-as-sensed is reached when implements themselves become indications. Unfortunately, the American workers who have taken up this question have not thought things out on sufficiently theoretical lines; and consequently the results they have achieved have no value at all. Who, having the slightest idea of what an implement is, would straightway proceed to the hardest problem of all,
and confront an animal with one designed for man's own use?

An implement is formed by a human function-rule, which
combines the most various
sense-qualities into a unity. How
can an animal inany way take up an implement as an indica
tion, if the function-rule is not its own but the observer's ?

PAIN

Pain forms one of the most powerful indications. It is an indication of the subject's own body, and its chief duty is to prevent self-mutilation. So it imposes a strong check which shall prevent, in all circumstances, the continuation of any initiated action that is hurtful to the body.

This is especially necessary in the case of carnivorous animals; rats, for instance, will immediately devour their own legs, if the sensory nerves to these have been severed.

THE INNER WORLD.—THE PHYSIOLOGICAL POINT OF VIEW

Differentiation of the sensory network appears relatively late. In many cases, a division comes about simply by the regions which belong to the various sense-organs separating away from one another. In such animals, the function-circle of the enemy employs other receptors and parts of the sensory network than those used by the function-circle of food.

As soon as outlines serve the body as indications, differentiation of the sensory part of the nervous system speeds off. For now it is useful so to combine quite definite sensory nerves of theeye, that their common or successive excitations are linked up into a whole, which makes its way into the guiding mechanism as a new unity. I have called these nervous unities "anatomical schemata," because they do not give a complete reflection of the outline in the external world, but merely a summary combination of its most important parts, and this with a degree of exactness suitable for the particular animal.

The appearance of such schemata in the brain is of two-fold importance. Firstly, it enriches the world-as-sensed with the things of space; and secondly, it permits the animal, as soon as the first spatial indications sound in the manner characteristic for the schema, to form the whole schema, and in this way to recognise the presence of, say, an enemy, when the enemy is only partially visible.

In the lower animals, the whole stimulus forming the indication must get going, whereas, when there are schemata, only the opening notes need sound for the whole schema to act as indication. In thisway, the schemata acquire a high degree of independence in the steering mechanism. The animal no longer flees before the direct stimulus of the enemy; it no longer is directly incited to seek its prey ; but it flees from and seeks for the schemata of these.

Further, there can be no doubt that the completely different behaviour of animals in the states of hunger and of satiety, is referable to change in the irritability of the central organs belonging to the food-circle. For a newly fed shark a dead sardine simply is not there, because in this condition the shark's "stimulus threshold“ is too high. But hunger lowers the stimulus threshold, and then the sardine appears in the sensed-world of the shark.

The purpose of this chemical organisation is to regulate thoroughly the guidance of the central nervous apparatus vis-a-vis of the influence of the indications. In comparison with this, direct stimulation of the nervous system is relatively negligible. For the most part, only a kind of "chemical tone" is attained, which, in full conformity with plan, provides that, according to the needs of the body, one function-circle shall find acceptance rather than another, by the indications thereof being more powerful or alone operative.

THE BIOLOGICAL POINT OF VIEW

Now we can see that a difference in principle is involved, when, on the one hand, the physiologist divides up the central nervous system into apparatus, and on the other, the biologist divides itup into organs. Where the physiologist analyses it into sensory and motor apparatus, the biologist makes a corresponding division into mark-organs and action-organs.

The mark-organ includes the framework + protoplasm, in so far as it serves for the creation of indications. The action organ comprises framework + protoplasm, in so far as it serves for the creation of a definite movement-sequence, which we call an action.

Every time an indication appears, a function-rule lies behind it, and comes to expression in the structure as well as in the activity of the mark-organ. In the same way, a function-rule lies behind every action, and finds expression in the structure and the activity of the action-organ. From this it follows that the actions of an animal can be closed within a definitive function-rule. This may express itself in an immutable framework, in which case an involuntary action or reflex is created. Or the function-rule may make the framework from time to time, as circumstances arise; then we get a protoplasmic instinctive action. Between these two sorts of action come the so-called plastic actions, among which actions based on experience are to be reckoned.
Finally, there are controlled actions, in which the function-rule of the action-organ makes its determinative appearance even in the mark-organ.

The physiological analysis of a central nervous system is finished, when the mark- and action-organs have been investigated.
The biological analysis is finished, when the function-rules for perception and for action are laid clear.

IMPORTANCE OF THE RULES OF FUNCTION FOR THE FUNCTION-CIRCLE

It is impossible to understand the relation between mark-organs and action-organs, and the interdependence of their function-rules, unless we first separate from one another the individual function-circles of which these organs form the keystones.

We must note that each circle—for instance, the enemy circle—is in principle always closed, however simple the indication that gives information of the enemy's presence, and even if it consists merely of a smell, or of a slight movement; the act, whether of flight or of defence, that serves to ward off the enemy, will always be initiated with completeness.

As we know, even objects are elaborate unities, extended inspace and in time. But implements arise in the world-as-sensed only when the subject's own action-rule endows them with a function: this action-rule combines all the properties and capacities in such conformity with plan that they are obliged to obey an inner rule, which we call the function-rule of implements.

So we human beings transfer our own function-rule to implements, just as we transfer to them the indications we ourselves have formed.

These are general laws, depending on the structure of each individual subject. And so it is quite inadmissible to impose on the sensed-world of animals the human function-rules on which, as something taken quite for granted, we base all the implements that fill our sensed-world. We must first get to know the action-rules of animals, before we can proceed to the question of implement-forming in animals. As soon as an observer turns his back on an animal, his human implements disappear, and only these really belonging to the animal continue to surround it.

Even the "psychoid," introduced by Driesch into natural science, is to be understood in this sense. The psychoid is an objectively active rule, which we must observe in operation.
The word psychoid indicates that here we have to do with a creation by the psyche, for a super-spatial law comes in, not belonging to the body, but controlling it.

THE WORLD OF ACTION

When we considered the world-as-sensed and the inner world of animals, we could not fail to recognise a certain parallelism between the physiological and biological ways of considering them, a parallelism which permitted of the two sciences being mutually complementary and corroborative; but when we turn to consider the world of action, this parallelism completely disappears.

INTER-ADJUSTMENT

In considering the inner world of animals, we have learnt to distinguish between mark-rule and action-rule. These two rules constitute only portions of the general plan that is expressed in the whole structure and in all the actions of animals. We have seen that organs are fitted into one another like the parts of a machine, and so we have spoken of framework. But there can be no doubt that this entire framework is likewise subject to a rule. This rule is manifested so clearly in the permanent anatomical frame-work that we need not discuss it further. On the other hand, we must seek for the rule of inter-adjustment, when the effectors, as they deal with the things of the external world, create a temporary framework.

As a matter of fact, in the world of action we are dealing with a temporary framework of this kind, which becomes apparent only when the animal shows activity in one of its function-circles. The most obvious inter-adjustment is that which connects the effectors of animals with the medium.

PERFECTION

We go on now to speak of a problern that is especially important in the function-circle of the enemy, when attacker and attacked come face to face. We may assert that, in all such cases, perfection is not attained, at least by one of the antagonists, for the one that is defeated shows, by the very fact of its defeat, that it was imperfectly equipped for the fight. Even when both appear quite remarkably well equipped for battle, and are perfectly fitted into the enemy circle as regards their effectors, this inter-adjustment must be imperfect for one of the two parties, if that is worsted.

If even in such cases the inter-adjustment, though apparently in conformity with plan, is really imperfect, then the plan of Nature is not perfect; and we have a right to be incredulous concerning the perfection of the framework of animals in general. This seems to justify the view that Nature is full of imperfection. The plan of Nature degenerates into a mere illusion, and what we admire as design might turn out to be a mere game of chance; which is what Darwinism actually assumes. It was not without good reason that Darwin made struggle the central point in his theory, for here there does seem to be a distinct hiatus in the perfection of design.

The limitations of the organism. This gap, however, is only apparent, and it arises from a false definition. Perfection is not omnipotence, but merely means the correct and complete exercise of all the means available. Even from the most perfect being conceivable we cannot look for the exercise of resources that it has not got. It must also be admitted that each animal, even if it employs perfectly all the means in its possession, cannot perform more than these permit it to do.

By its resources, limits are set to the achievement of every animal. The sum of all the resources at an animal's disposal—such as the nature of its structure, the material of which it is made, its strength, its size, etc., i.e. the sum-total of all its properties and capacities—these make the organism.

INTER-ADJUSTMENTS WITHIN THE ENEMY AND PREY-CIRCLES

SUBJECTIVE AND OBJECTIVE ANNIHILATION OF THE INDICATIONS

If we combine what we learn concerning the actions in all the function-circles taken together, we may say that the outcome is the annihilation of the prevailing indication that led to the action, and this automatically brings the action to a conclusion. Annihilation of the indications takes place in two kinds of ways, which differ from one another in principle.

THE INDICATORS

In considering all the various indications that surround an animal, we perceive that the indicator towards which the animal's action is directed, is very differently constructed according to the particular inter-adjustment between it and the animal.

If in the enemy-circle a simple movement of flight follows on a certain indication, whether that be of chemical, acoustic or optical nature, the indicator is merely the bearer of the property that is employed as indication by the fleeing subject.

If, on the other hand, effectors come into action that serve for defence, the indicator has a counter-framework which fits in with the framework of these.

THE COUNTER-FRAMEWORK AS EXPRESSION OF THE FUNCTION-RULE

The study of the counter-framework in the indicator forms an especially important chapter, for by this a connection is established between the world of action and the world-as-sensed; and the surrounding-wbrld emerges as a self-contained unity, enveloping the subject on all sides.

The function-rule, consequently, relates not only to the framework of the subject that it governs, but also to the counter-framework of the animal serving the subject as enemy or asprey. It includes, however, only the counter-framework from which the indicator is constructed, and completely excludes suchparts of it as come into consideration when that other organism is the subject.

Not until we have completely worked out all the function circles of an animal, do we get some idea of the closed surrounding-world, which on all sides shuts off each individual subject from the rest of the world, and forms the only outer world it knows.

A dog, for instance, is not merely a tool that we use for hunting; but—quite apart from its services to us—it embodies for us human beings a whole number of action-rules, when it barks, eats, runs, etc., and these combine together into one extremely complex action-rule for the whole.
In this way the indicator "dog" becomes for us the epitome of a rule assigned to it for the totality of its actions; and this rule distinguishes it from all other indicators.

We may then make the following statement, as the basic principle of biology:—in all surrounding worlds whatsoever, the indication-bearing and the action bearing properties of a function-rule are held together by the counter-framework of the same object.

THE WISDOM OF ORGANISMS

From human analogy we are far too ready to seek in the subject's knowledge the source of the correspondence between an action and its use to the agent, a knowledge that is present as mark-rule in the mark-organ and is able to foresee consequences. This is why the unfortunate expression " purposefulness in organic Nature" is always used, and also why so much value is attached to the psychology of animals.
Now thepsychic processes assumed in animals can play but a transient part in their lives. When we speak of what the psyche does, we can only mean by that the rules in the mark-organ as observed from within, and we shall not get far if wetry to build up the purposefulness of life upon such a basis.

And what would become of man himself, if he depended for direction merely on his own knowledge of his psyche? The ideas that most people have concerning what goes on in their own bodies are exceedingly meagre, and, for the most part, incorrect. Modern hygiene gives us a great deal of information as to the marvellous wisdom of our tissues in their fight against foreign poisons ; but of this we should never have been conscious ourselves.

This force of Nature we have called conformity with "plan," because we are able to follow it with our apperception only when that combines the manifold details into one whole by means of rules. Higher rules, which unite things separated even by time, are in general called plans, without any reference to whether they depend on human purposes or not.

Instead of conformity with plan, we might just as well speak of conformity with function, or of harmony, or of wisdom. The name does not matter; what does matter is that we should recognise the existence of a natural force, which binds according to rules. Unless we do this, biology is sheer nonsense.

MODERN ANIMAL PSYCHOLOGY

In recent years, since the appearance of the talking horse of Elberfeld, animal psychology has struck out new lines, and these are so worthy of consideration that we cannot pass them by unnoticed.

The statement that the psyche of animals contains within it this sensation or that, does not concern biology. It is for the psychologists to picture the animal soul as they think fit. The biologist must concern himself solely with such manifestations by animals as are perceptible by the observer; and from these he must draw conclusions as to the organisation.

But modern psychology affirms that all animals, or at least all the higher animals, have a human intelligence, which is not expressed simply because the bodily organisation sets limits to it. If we succeed in getting an animal to produce a suitable sign-language by means of its organs, we can converse with it as with human beings. This view should undermine the opinions held hitherto in comparative psychology, which infer the nature of the psyche from that of the organisation.

CHAPTER VI
THE GENESIS OF LIVING ORGANISMS

EVOLUTION AND EPIGENESIS

Hitherto we have been concerned only with the rule of the finished object, which we called its function-rule. In living beings we also met with a function-rule, which governs their doings independently, whereas the corresponding rule of implements has reference to a human performance, and so is always dependent. Accordingly we speak of the counter-actions of implements, in contrast to the performances of subjects.

Apart from this difference, the function-rules of implements readily admit of comparison with those of organisms. In both we find a fixed framework, which forms the externally visible expression of a rule. The framework is responsible for carrying out the action that follows the function-rule. From what we know of thespatial rules of the framework, we may confidently deduce the function-rule. So we have been able to show that, among animals, in so far as concerns the activity of the framework, all those mechanical rules hold good which we know in our own machines.

Indeed it is possible, up to a certain point, to imagine machines possessing a mark-rule and an action-rule, as though they were animals. But such rules are not susceptible of any change, for machines consist entirely of a fixed framework, and all the rules that can be deduced from their spatial structure and their functions are human rules; these do not belong to the machines, but are introduced into them from without.
Consequently they can be altered only from without, by human intervention. And that is why we say that the running of machines is conditioned.

When machines wear out or are injured, their function-rule cannot immediately come to the rescue, as would happen if they were organisms; an organism has its function-rule within itself, and in protoplasm the material which the rule independently employs for repairing the damage.

For two hundred years the dispute has raged as to whether it is necessary to assume a special rule of genesis for living things. Natural science, elsewhere so ready to apply the analogy with machines, has here, strange to say, made an exception. As soon as the spermatozoa were discovered, it was thought perfectly obvious that here we had human beings in miniature, which only had to grow to full size in order to be completely developed. This was the foundation of the later doctrine of "evolution," which saw in the genesis of the organism merely a process of increase in size. The theory of spermatozoa-men was soon shown to be wrong. Biologists then seized on the idea of plant-buds, which not only grow, but must unfold in order to produce leaves. And so arose the doctrine of unfolding or genesis or "evolution."

This doctrine was opposed by Wolff, who, as a result of his exact observations, became convinced that in the genesis of the living organism there could be no question of a mere unfolding. For Wolff, genesis appeared as a perpetual creation of something new, an epigenesis.

Epigenesis, being the more difficult doctrine to grasp, had a hard battle to fight, but it conquered at last through the overwhelming power of facts. Again and again the evolutionists attempted to maintain the dogma of an invisible framework present in the germ from the beginning, by assuming hereditary particles, which, in some way or other, were spatially connected together.

Finally there could no longer be any question of evolution in the old sense; a real revolution was necessary to bring all the minute parts of organs into reasonable arrangement.

Haeckel's so-called "biogenetic law" was mainly responsible for giving evolution its last foothold. This law consists in the assertion that in the course of its individual development, every single organism passes through the developmental history of its ancestors, in abbreviated form.
Since the history of the ancestors is unknown, it was deduced from the development of the individual, and so was proved by a vicious circle.

The vast amount of " literature " that has been written with this fallacy as basis, almost passes belief. And so we may consider it a real feat, when Driesch put an end to the business by demonstrating that in the germ there is no preformed framework for the complete animal.

The proof adduced by Driesch is just as simple as it is enlightening. The essence of a framework consists in its being made of parts fitted together; and when one tears it asunder, it is a framework no longer. If there is an invisible framework present in the germ, then, when the germ is cut up, the framework must be cut up with it. Now, a halved germ, if it develops further, yields, not two half-animals, but two animals of half the normal size. This fundamental experiment of Driesch's has been performed with all possible variations, with every possible precaution, and on all suitable species of animals.

GENERAL PROLOGEMENA

With the final proof that, at the beginning of embryonic shaping, there is no framework in the germ, but that there is a rule, the modern doctrine of the genesis of the organism began. What the nature of this rule is can be deduced only after the history of the genesis has been laid clear. The question "How does a rule affect the protoplasm of the germ?", we answered when we considered the super-mechanical powers of protoplasm, by saying that it arranges the impulse-sequence.

But the discoverer of the impulses was Mendel. The story of this discovery will ever be worthy of remembrance. In the sexual crossing of peas Mendel discovered the rule of interchange of the rudiments of characters, a rule which holds good for sexual crossings in all organisms. But, as happens to great geniuses whose intellectual course lies far from the beaten paths, Mendel's contemporaries, strolling confidently along the comfortable high-road of Darwinism, did not understand in the least what his inquiry meant. And so this great discovery was quite lost, until, eighteen years after the master's death, it was rediscovered by three scientific men simultaneously.

What Mendel discovered was an entirely new natural factor, which only to his peculiarly endowed spirit appeared self-evident. To Mendel it seemed so obvious indeed that he gave it no name, and was interested only in the law in which this factor expressed itself.

It was Johannson who first recognised the necessity for naming the new factor, and he called it a "gene." This name tells us nothing about the nature of the factor. And those investigators who first tested the general applicability of Mendel's law were not concerned with the conceptual classification of the new natural factor. The new knowledge led to practical results of the first importance in the cultivation of plants and animals, which called for the undivided energy of these distinguished scientists.

THE GENESIS OF IMPLEMENTS

As already emphasised, all human appliances agree in that they are supposed to have a rule of genesis in addition to a rule of use. And this fact requires that we shall make the genesis of implements the basis of our consideration of the genesis of organisms.

MORPHOLOGY

We may briefly define morphology as the science of the signs of genesis, for its task is to analyse organisms, not into their functional, but into their genetic building-stones. By homology is understood the interrelations of these genetic building-stones; by analogy, the relations of the functional.

It happens not infrequently that animals inhabiting the same medium and living on the same prey, or hunted by the same enemies, show, in correspondence with their approximately similar function-circles, a similar kind of construction in their effectors and receptors. But such animals are not related to one another, if the morphological laws of their structure are different. They are analogous to one another but not homologous.

Inevitably we assume homologies between animals now living and their ancestors, and up to this point it is justifiable to employ the morphological laws of structure for the determination of lineage. But we must altogether abjure the Darwinistic misuse of these laws.

Morphology is a science that concerns itself with the centrifugal mode of structure of the cell-mosaic of which all organisms are composed. Where the support of embryology is lacking—in palaeontology, for instance—morphology is concerned solely with the search for signs of genesis. To avoid going astray through taking a sign of function for a sign of genesis, morphology must call in the help of comparison.
Only when we have shown that, in spite of change of function, the same anatomical characters persist in various genera and species, can we decide with any confidence as to which are signs of genesis.

For instance, the fixed number of seven cervical vertebrae in all mammals, whether they have a long, flexible neck like the giraffe, or a short, rigid neck like the whale, is undoubtedly to be taken as a sign of genesis. On the other hand, the arrangement of the lamellae in the bones of mammals, which changes according to the distribution of the weight of the body, is a sign of function.

From study of the animals now living, it appears that the higher animals display, as transitory stages, rudiments of structures that become organs in the lower forms; in the former these do not reach complete development.
This fact, however important it may be for the determination of relationship, is no more than an expression of the centrifugal architecture of animals. - How else, indeed, should this centrifugal architecture express itself from the germ?
Surely it is just what we might expect that, when we compare various kinds of animals together, the first systematic arrangements in the mosaic should resemble one another, and then, after a certain time, become differentiated from one another. A continuous chain of shiftings and changes characterises the development of even the highest animals; and so we get the impression that certain stages are to be explained only on the assumption that they belong to the organogeny of lower animals, which have branched off at an earlier date. It will never be possible to prove that the organs of the higher animals can be formed without these "detours."

All such ideas originate from making a quite uncritical assumption of an analogy with the centripetal architecture of human implements, and then applying it to the centrifugal architecture of organisms.

Yet one thing more. The child is never created from the mature organs of its parents. Rather, the child, since it comes from the same germ-plasm as its parents, travels the same path of genesis as they, in order to develop finally its individual form. This form is not based on a model all ready prepared, but represents the definitive conclusion of a life process that never before ended up in this particular way. And so it follows that the definitive form of an organism can never harbour within it thevestigial remains of an organ that once upon a time was functional.

THE MOSAIC THEORY

Undoubtedly we are entitled to regard each organism as a cell-mosaic; in so doing, we refer to the cell as the smallest stone in the mosaic, and from this all the genetic building stones are composed. Now, if this body-mosaic arises from a germ-cell, we may ask, "In what form are its rudiments laid down in the germ?"

MULTICELLULAR ANIMALS

This interlocking of the two rules, which is characteristic of unicellular animals, ceases altogether when we come to multicellulars, in so far as these consist of permanent organs.
The life of such animals falls into two distinct parts. In the first, the organs are formed; in the second, they are used. In the first, the rule of genesis controls; in the second, the rule of function. Accordingly it is possible in multicellular animals to observe the rule of genesis more clearly at a given time, since it proceeds quite independently of interference from function.

As soon as a germ-layer has been laid down, its cells each retain only a limited formative power. It is natural to suppose that, in the nuclei of all the cells of each of the three germ-layers, only one-third of the genes are present, while two-thirds disappear by unequal division of the chromatin or are dissolved (genolysis).

The same thing appears later on when the germinal areas are mapped out within the germinal layers, areas which are to produce certain organs. As soon as a germinal area is marked off, the cells that compose it forego the power to form the organs of another germinal area.

It may be taken as a fundamental law of genesis that, when a structure appears, this excludes the power to form anything else. And so, as development proceeds, it is accompanied by impoverishment in formative cells, and this we must refer to the loss of genes.
Through the loss of genes, the effect of the impulses, which manifest themselves in the individual cells, becomes more and more restricted and specialised, so that finally the definitive cells of the full-grown organism retain in their reserve-plasm, which does not enter into the framework, nothing but the power to furnish that with special cell-frame work in the event of injury.

Anexception to this rule is offered by the sex-cells, which arise from the first divisions, and pass over into the sexual organs of the adult unchanged and with all their genes.

The phenomenon of the systematic loss of genes is as important to the course of development of the complete animal as is the release of the genes, which likewise takes place conformably with plan. Here also is to be seen an invasion by the impulses according to plan, an invasion belonging to the general melody which all the impulses obey.

In many of the lower animals the loss of genes is not so rigorously carried out as it is in the higher. This permits of regeneration after extensive injury, to a much greater degree than is possible among the higher animals. In the case of self-mutilation especially, the cells, at least at certain places in the body, must remain in possession of numerous genes in order to make good the loss.

THE IMPULSES

When we consider the Mendelian properties, the genes of which lie ready prepared in the germ, we find that they include not only chemical properties, but also properties relating to form. We may confidently assume that the components of the chromosomes represent the genes; but in considering the material basis of the genes we must not forget their non-material aspect, and that lies in the impulse, which follows the rule of the subject.

As already explained, the material basis is probably a ferment, which in a latent form lies waiting in the chromosomes. But, in addition, the gene consists of the non-material impulse, and this it is which activates the ferment.

The difficulty we experience in understanding how the form-giving genes work, lies in this, that, although they are tied to a definite place in each individual cell, yet they must act according to a system which is not present anatomically, although it embraces a whole germinal area with many hundreds of cells.

But this difficulty disappears when we realise that it is only the material basis of the genes that is of necessity bound to a definite position in space, whereas their non-material portion, the impulse, is not bound in this way.

The impulse always plays an active part, now stimulating a gene, and now an anti-gene. An impulse, which is not fixed to a definite position in space, may easily be connected up with other impulses into a system.

We may say that the genes are "impulsive," but by that term we must not presume a physical energy, following the rule of causality; rather, we must understand the power to convert an extra-spatial and extra-temporal plan into a physical phenomenon.

This enables us to understand the point of view of Bunge, who first made the statement that " in activity lies the riddle of life."

On the other hand, Baer's theory, which compares to a melody the laws regulating the genesis of an organism, assists us greatly in our attempt to understand things. In place of melody, we may also speak of rhythm or of symphony, according to whether we have in mind the rules of the impulses in their simultaneity or in their sequence.

With regard to its functions, the subject in the germ-cell is still very simple.
But in the genes it possesses a very large number of unexploited possibilities which will enable it to expand in every direction. As the possibilities are made use of, their number becomes more and more restricted. What the subject gains in shape it loses in fresh life-possibilities. Thus the frame work slowly increases in complexity and solidity but it becomes more and more like a machine, and loses one super-mechanical power after the other, until finally there is left in each cell only a remnant of the protoplasm containing the genes that serve for the necessary repairs. The framework restricts framework-formation.

With the completion of the framework, function sets in; function which, on the one hand, seems an outcome of the finished machine, but, on the other, controls it, for its rule is now substituted for the rule of genesis, and, in accordance with plan, guides the course of what happens.

While in unicellular animals the rule of genesis and the rule of function simultaneously affect the course of the impulses, in multicellulars there is a critical point at which guidance of the impulses passes from the control of the rule of genesis to that of the rule of function.

THE FINAL STAGES OF GENESIS

The individual impulse-system is dependent on the material only in so far as that must yield the suitable genes if the system is to become manifest. It is dependent on the adjacent systems only in so far as its fixed position is determined by its being set between them. For the rest, development within each system proceeds quite independently, according to the general rhythm which is prescribed to the systems collectively ; it is all one whether the normal quantity of material ispresent, and there is no regard paid as to whether adjacent systems shape structures in a normal way, or produce only a reduced organ, or no organ at all.

All of which proves to us the existence of an independent natural factor, representing a self-contained rule built up of part-rules, which, on their side, arrange the impulses both in space and in time.

Once the impulses are set free, it does not matter whether they achieve a material effect or not; the rule of genesis proceeds calmly on its way, and sends forth its impulses according to its own law and rhythm.

The rule, although it breaks up into separate part rules, is in itself quite independent of space and time.
The impulses that obey the rule, are fixed in space and time, but in themselves are still completely non-material. But, since they are attached to the genes, they dominate the material, for that is set in motion by the fermentative action of the genes. The genes themselves represent a union of a latent ferment with an activating impulse.

A gene has very different aspects according to whether we regard it from the standpoint of plan or of causality. In the former case, all we see are impulses which obey an extra material rule; in the latter, we see a ferment which produces certain physical and chemical effects in the protoplasmic foam.

The genes are connected together by Mendel's law. In so far as this relates to the mixing of the genes, it is a law of probability, pure and simple; in so far as it refers to the dominance of certain genes, it is a biological law. Those cases in which the dominance is notperfect and the recessive character also finds expression (as in the Andalusian fowl, where the blue feathers come from acrossing of white and black parents) indicate that both genes are set in activity, but, for the most part, the recessive ferment is blotted out by the dominant.

THE CRITICAL POINT

I call the critical point that moment when the subject, on completion of its shaping process, suddenly finds itself in possession of a framework fully developed and capable of functioning.

In the majority of animals the critical point becomes clearly apparent when the creature leaves the egg, or when it is born. In other animals, through interposition of a larval period, the critical point is not so obvious. This difference is the result of external circumstances whichgovern the taking up of food and the growth during the process of shaping.

The functionalactivity of the developing animal never ceases altogether. The foamy framework of the protoplasm is involved in a continual metabolism, and for this it requires a steady food-supply in order to make good the energy expended. The need for food becomes very intense on account of the growth that accompanies the shaping. Nutriment is furnished by a reserve supply accumulated in the germ, or it is brought by the maternal organism, or it has to be got by the animal itself. In the last case certain genes must provide larval organs serving for food-capture; then the animal as a whole continues functionally active throughout its development.

When the food is furnished by reserve substances or by the mother, provision is made by development of special food-routes for the supply of nourishment to the individual cells, without the entire organ-system taking part in the digesting activity; for the system of organs is at that time busy with its own development.

This state of things changes as soon as the framework is completed and the function of the fully-formed subject begins.
The majority of animals at this stage are not yet full-grown, but need a longer or shorter time before they reach their definitive size. Indeed, there are animals, such as some kinds of fish, that are never full-grown, but go on increasing in size to the end of their lives.

As Wessely has shown, growth during this period no longer obeys the rule of genesis, but the rule of function.

Before the critical point has been reached, the impulses governing growth follow exclusively the general rhythm of the whole germ according to the rule of genesis. After the critical point, growth is governed by the rule of function.

Now the critical point is not passed by all organ-systems at the same moment;inespecial, the cerebrum of mammals shows an important retardation in its development.

The rule of genesis proceeds on its appointed course as an independent natural factor as far as the critical point, but no further. Its routes can be recognised by morphologists through the signs of genesis, and these furnish points of support for determining the relationships of animals. The rule of function, however, acts like a new broom, which sweeps away all that is useless, and retains only what is necessary.

Anorgan that functions has passed the critical point, and it degenerates if, later on, it is put out of function. The most exact information we have about the degenerative processes concerns the nerves.

SUBJECTS

Each cell retains both its vegetative and its animal functions, but these are now devoted to the service of the whole. Like the free-living amoeba, every living cell has to capture food, and has to carry on metabolism. But the food is brought to it in the body already so well prepared that it is deprived of the function of digestion, and can straightway make the food a part of itself. Like the free-living amoeba, every cell of the body possesses the power of transforming stimuli into excitation, and has some limited power of movement. In every cell, therefore, there is a modified reflex arc.

According to the position that the cell occupies in the body, part of this reflex arc is hypertrophied and part degenerates. In the case of sensory cells, almost the whole becomesreceptor; in the nerve-cells, almost everything is a path of conduction; and in the muscle-cells, it is practically all effector. The same law can be shown to hold good for the cells of the vegetative organs.

Thus each cell remains an autonomous subject, the framework of which, in contrast to free-living cells, insinuates itself into a surrounding-world which is itself a subject.

THE BIOLOGICAL AND THE PSYCHOLOGICAL SUBJECTS

The contradiction that seems to be involved in the definition of the subject indicates that we have not yet elaborated the idea of the subject sufficiently.

Psychology employs the concept subject for the "ego," and understands thereby the unity of the process of apperception; at the same time it regards the ego as the source of the ordered impulses. From the standpoint of biology, which considers the subject from the outside, the first part of the definition is of no value. The subject of another is always merely a formation of our own apperception; only the psychologist who has introduced himself into another subject can say something about its apperception.
The second half of the definition, however, is biologically admissible, for here we are dealing with effects of the ego in the direction of the exterior.

The impulse introducing the voluntary action possesses no quality, and we know of it only from its existence. Everything that takes place during the action comes to our consciousness only through the indications of the direction-signs, local signs and content-signs.

The impulse-sequence, just like a phenomenon in the external world, is perceived by an outside observer only through external indications; and this permits of our making certain important comparisons.

I have already indicated the different types of action that we can distinguish in the life of animals. These are the reflex, the plastic action, the instinctive action, the action based on experience and, finally, the controlled action—which last, however, plays a part only in the highest animals.

The plastic action has been thoroughly analysed by Pawlow. He succeeded in demonstrating that, in dogs, the secretion of saliva and of gastric juice (which are considered reflex actions because in human beings they proceed without an impulse of the will) are nevertheless regulatable or plastic. Dogs whose salivary secretion appeared only when they smelt food, learnt to secrete it also in presence of optical, acoustic or thermal indications, where such invariably preceded feeding.

Accordingly it is possible in this case so to modify the fixed framework, which releases the secretion as a reflex only when the olfactory nerves are excited, that it becomes focussed on new indications. In this way the indicator is furnished with new indications, and this means a considerable invasion of the dogs' world-as-sensed.

Thus thesubject reveals itself to us first as an architect, and then as a director of affairs. We ourselves experience our subject always through the medium of the qualities which accompany the impulse-sequences of our actions.
The material plan of the framework in the body of the organism is thus referred to a non-material plan, which, so long as it represents for us a closed unity, we call a subject.

GENERAL CONCLUSIONS

There are material systems that work in accordance with plan; in these, material processes go on strictly according to the rule of causality. The material systems are either dead or living. The dead systems have only a rule of working, which we read from them, but which is quite without effect on the framework. In the living systems run according to plan, there is a reciprocal action with a rule which we call a rule directing the working. This is not a mere formula; it is a natural factor.

The plan appearing in rules affects the material indirectly by means of the impulses. Causality, in contrast to plan, affects the material directly, and requires no impulses for the attainment of its object. Like all material factors, it is employed by the plan to form framework functioning in accordance withplan.

Though we may have established the purely causal running of a process, yet conformity with plan is not thereby excluded, for, in what it does, the completed frame work, working in accordance with plan, does not show the slightest departure from causality. Only when the framework suffers injury, does it become apparent whether, in addition to causality, there is a plan at work.

THE TOOLS OF ANIMALS

Let us at onceget rid of the mistaken attempts to compare with one another implements such as birds' nests, and to setup an ascending series indicating the gradual advance towards perfection. Each implement can be judged only with regard to its counter-action for a particular animal, and consequently the implements are as non-comparable among themselves as are the animals that make them.

All implements of animals that we know as yet, arise through instinctive actions, in which neither memory nor experience play the slightest part. A bird that has grown up in altered conditions and has never known the parental nest, makes one for itself on exactly the same plan as that which governed the nest of its parents.

In principle, it is quite unnecessary that the tools an animal has fashioned should appear as such in its sensed-world. As I explained, an implement appears in the world-as-sensed only when the rule governing the course of the activity in the action-organ affects the mark-organ in some way, and there forms the basis around which the indications arrange themselves.

SUMMARY

Consideration of the function-world of organisms showed that the animal-subject is not to be sought in an ego localised in the brain, but that the subject governs the entire frame work of the animal body.

Study of the genesis of animals disclosed, to our surprise, a new rule, which forms the framework. Karl Ernst von Baer, it is true, recognised that in the development of the animal body from the germ onwards, a special natural force must be active; and this he called "effort towards a goal," because the finished framework always forms the aim of the processes during genesis. But it was the pioneer discovery by Mendel that first made it possible to analyse this natural factor.

As soon as the framework is completed and the function sets in as a purely material process, the control over the impulses passes from the rule of genesis to that of function; this comes to the rescue when there isany injury, and, also with the help of the genes, carries out the repairs; in addition, it controls the growth of the formed but not yet full-grown animal.

To describe two different things as "rule of function" may easily lead to confusion; so we might speak of a function rule kept in permanence by a function-regulator.

If we choose to use this term, then the subject is distinguished from an implement by possessing an autonomous function-regulator, and it also has an autonomous rule of genesis; this, being likewise a natural factor, may be called genesis-regulator. Thus the subject, as the visible manifestation of the union of both these regulators, forms the most important natural factor in biology.

CHAPTER VII
THE SPECIES

The species has its origin in the concept of similarity. We say that organisms are similar which are not quite alike but are just distinguishable from one another in a certain respect.
If several organisms are to be studied with reference to their similarity, we choose out a special individual as a sample, and compare with it those nearest to it. Then we go on to determine everywhere the just perceptible differences, and in this way we unite together the whole group of organisms. When that is done, the group appears to us as a continuity, which we call "species."

Within each species we shall always find an individual which lies midway in regard to the total of all the deviations. We call this the "typical case," while those individuals most remote from it in any direction are called "extreme cases."

It is not at once obvious whether a species is a product of Nature, or whether it is to be considered merely as a means of classifying. But after it had been shown that all living things can be combined into continuous groups or species, and that these are separated from one another by larger gaps, men believed that they were justified in interpreting species as special products of Creation, whereas the individual "variations" within the species could change in the course of ages.

It was natural to go on to suppose that, in the course of ages, individual variations might drop out, and, as a result, the originally coherent species would cease to appear continuous, but would produce the impression of being two species. It is the questionable merit of Darwinism to have followed out this idea to an extreme, with the result that all gaps within species are filled in with products of the imagination. Darwinism could not really shake the fact of the existence of species quite distinct from one another; so it contented itself with ignoring the differences, on principle.

Things being so, there is no putting an end to the dispute as to whether the species is purely a means for classification necessary for the systematising of the vast number of animal forms, or whether it is the result of a systematising force of Nature.

But there is no agreement even in the methods employed in defining species, quite apart of their position vis-a-vis of Nature. All naturalists highly gifted with intuition, and of these Goethe was the supreme instance, start from one single instance or "typical case," group similar animals into a species around it, and determine the various deviations with reference thereto. For such men the species embraces all the deviations that branch off from the type of the animal selected.
For less "intuitive" naturalists, the species forms merely a group of similar individuals united by a certain rule.

In both cases it is open to doubt whether the rule by means of which the species is held together is merely a conceptual rule, or whether we see in it the expression of a natural factor.

To the question "Is the species a natural factor?", Darwinism, with the naive confidence so characteristic of the whole spirit of that time, unhesitatingly replied in the affirmative. Since Darwinism was extraordinarily little gifted with intuition, it saw in the species merely a mixture of properties, such as one might find in any mass of fermenting matter. The species like the individual, must be reduced to a product of natural forces acting without regard to plan, for the existence of such forces acting in accordance with design was denied.

THE GENOTYPE

Johannsen is responsible for introducing the distinction between the appearance-type, or phenotype, of an organism, and its rudiment-type, or genotype. By this means, certain variants were referred to the effects of the environment during genesis, and others to climatic and local influences, while yet others were based on differences in the genes, present from the very beginning.

The phenotype is exposed to all manner of external influences, whereas the genotype is stable; this means that thegenes present in the germ are inherited unchanged, so long as there is no crossing with other genes.

As we already know, there lies ready in every germ a definite number of quite definite genes, which together represent the genotype. They themselves have as yet no framework, but, through the ordered advent of impulses, they are enabled to produce it. Through the crossing of different individuals of the same species, these genes are reciprocally exchanged, in accordance with Mendel's rule.

If we consider the crossing, within a species, of individuals that vary very much from one another (as in the fly Drosophila ampelophila, which we know from the fine work of Morgan and his pupils), we see that, compared with the sample animal, the species possesses a much greater number of genes, many of the properties of which absolutely contradict one another. As well as genes for all conceivable kinds of eye-colour, we also find genes for eyelessness. Likewise there are genes for certain shapes of wings, and others for wingless ness; and so forth.

Starting from this fact, the species has been defined as that number of different individuals which, crossed with one another, continue to produce offspring capable of living and of reproducing themselves.

The question arises whether the species likewise has a genotype, or whether the boundary of one species with regard to others is decided by the possibility that, when too large a number of deviating genes meet one another, an individual capable of living can no longer be produced through crossing, for external, physiological reasons. Have we here a perpetual process of "trial and error" going on, which sometimes succeeds and sometimes fails? Or is the species a whole which works in accordance with plan, and is held together by a fixed rule? If so, what is the nature of this rule?

WHAT THE SPECIES DOES

A whole that is incapable of performance is merely an object, it is not even an implement, and still less is it an organism.
This criterion may be applied to the idea of the subject that we must make for ourselves. Thespecies, and Mendelism confirms this, is not a mere classificatory formula created by us in order that we may get a better view of the whole: it is a real natural product, characterised by the fact that the individuals composing it are not in a condition to cross with those of another species. But is the species also a natural product arranged by some plan, or is it merely an object produced by mechanical causes?

We must bring forward proof that the species as a whole expresses life in a unified way, and that in this expression somehow the parts determine the whole and the whole the parts; and this can be shown only if they work in common.

Strange to say, there is only one species of which we assume as obvious that it has a common task or performance, and that is the species "man."
In especial, the existence of dark-coloured races of men in the hot zones and of light-coloured in the cold zones indicates that to them all is set the common task of "dominating" the globe. Since the individual human being cannot simultaneously have a white skin and a black, it seems obvious to us that, to attain the common aim, there must be separate beings with different properties.

If we could build up together the function-circles of all the individuals of one species, we should get the common surrounding-world of the whole species, and, in correspondence with the deviations of the individuals, this would be larger and fuller than that ofany one of them.

Although each organism is perfect, in the sense that it exploits to the full the means at its disposal, yet the perfection of the species is higher, because the limits that are imposed on the individual are shifted much further back. An individual cannot be black and white at the same time, nor swift and sluggish, nor large and small. But aspecies can possess and bring to realisation contradictory properties simultaneously, because it is not bound to the function of one single framework.

THE PICTURE OF THE SPECIES

Framework and action are always restricted to the individual organism, and only at one stage, that of sexual union, is there an inter-adjustment that does not belong to the plan of the individual, but to that of the species.
What shows us clearly that here the species itself comes in and determines the shaping is not the renewal through offspring, but the mixing of the properties.

The creation of new subjects from the rich material of the genes affords the species the possibility of shaping itself anew with each generation. Without this, there would be eternal repetition; and so new variations on the same theme continually make their appearance.

Were it not for the perpetually repeated union, the species would break up into long, uniform chains of individuals; whereas, the union of all the chains in pairs continually revives the unity of the chains considered collectively.

The framework and the inter-adjustments of the individual organism are in themselves so manifold that it is impossible to take them in at a glance. The species is a thousand times richer than the individual, and consequently impossible to grasp in its entirety, if we consider it merely as the sum of its members. We can arrive at an intelligent notion of the truth only by grasping the species as a unity and confining ourselves to the ultimate inter-connections that bind it into a whole. Then every species appears to us as an ingenious structure formed by Nature, the several parts of which, as they separate from one another, are perpetually reunited and renewed by the sexual process and the inter-adjustment of the sexual organs.

RACE—PEOPLE—FAMILY

Thelarge species readily fall into groups, which are arranged around a typical sample animal. Among these sample animals, one can always be found that serves as such for the whole group.
Such groups, which usually display a marked tendency to avoid mixing with one another, are called races. We see in them the starting-point for the formation of new species.
Races are divisible into peoples, held together, as a rule, by geographical circumstances, which afford them special conditions essential for their life.

The ultimate member of the species is the family. Races and peoples may be described as subdivisions of the species, but the family is the true building-stone of this elusive natural unit. In the family occurs the mixing of the genes that makes of the species something other than the mere renewer of the same individual.

The family forms the visible expression of the species; in it we see the effect of the continually recurring tendency to union which prevents the species from falling asunder. The family provides that the perpetually renewed reciprocal action of the treasure-store of genes continues vital and unified.
It is through the family that the fullest conceivable reciprocal exchange of properties is ensured.

Through Mendel we have learnt about the distribution of the parental genes to the offspring. But the laws according to which the parents find one another in order to effect this distribution have as yet been little studied. It is here that sexual selection, so-called, plays its important part. As Darwin showed, the breeder can step in in place of natural selection, and produce new races and peoples within a species.

THE GENUS

The genus does not represent a connection between families. Nevertheless, it is not considered as a mere human means to classification, but as a true product of Nature. We assume that thegenus depends on the relationship of species one with another. Now relationship can be based only on the family. Therefore we assume that, countless years ago, separate offspring arose from one family, which so differed from one another that they no longer crossed, and in this way they established new species.

The species as a means to classification

As soon as we regard the species merely as a means to classification, we take up a totally different position. In such a case, we are no longer concerned with bringing into line the whole wealth of species, but merely seek for a group of characteristics that are displayed by all the individuals of one species, and at the same time are typical of this species alone.

This is made possible by the fact that all the interchangeable properties of the individual organisms within one species are built up on a stable basis of properties common to them all. The species belonging to one genus have, in addition, a smaller stock of properties, which, after removal of the group of characters typical of each separate species, remains over for the genus.

COMMUNITY AND SPECIES

We have already learnt that the impulses may obey two rules; for the rule of genesis controls the impulses in the embryo, and the rule of function those in the full-grown organism.

The individual organism formed during development in such a way that it becomes a structure capable of functioning, becomes at the same time a member of the community, and, by the mere fact of its existence, forms a part of the species.

So every individual being, when it is completed, is a product of three rules—the rule of the species, the rule of the community and the individual's rule of function. All three rules, therefore, must together have been determining the rule of genesis, which imposes their arrangement on the impulses.

THE WEB OF LIFE

When individuals are merged in the species, their immortality and immutability are sacrificed in the interests of life, and this shows that the two interests are not identical.
Moreover, each organism is obliged to take on a new function-circle, which it can perfectly well get on without. The sexual-circle requires special effector apparatus and a special steering bearing on special indications. This imposes an extremely heavy burden on the framework of the individual, and means a great increase in the dangers it has to run, for at the breeding time the other function-circles are forced into the background.
And thus, in the interests of the preservation of the species, that of the preservation of the individual is thrust into a second place.

THE EVOLUTION OF SPECIES

It is remarkable, to say the least of it, that the Darwinians always speak of the evolution of the individual, but never of the evolution of species, although they distinguish between highly evolved animals and primitive animals.

Indeed the entire genealogical tree of animals, which we see depicted in zoological text-books, is supposed to represent an evolutionary sequence from the simple to the complex. And Darwinians love to place the evolutionary idea in the forefront of their expositions. Why then this inconsistent avoidance of an evolution of the species?

It is because the whole sequence of the various species which palaeontology reveals to us from the Cambrian up to the present day, is regarded by them, not as a life-process, but as explicable by chemical, physical or mechanical causes.
Variation, according to them, is a chemical process which, without any plan, creates organisms, from among which the struggle for existence exterminates the unfit, i.e. those in capable of life, so that a selection of the fit is effected.

The genealogical tree is not meant to give a picture of an inner growth, but merely the result of the influence of external factors. The shape given to the animal kingdom at the present day is the outcome of the action of physical factors on a chemistry that displays no conformity with plan.

I simply cannot understand how, holding such views, men can talk of an evolutionary idea. For the external factors can atany moment become such that, by extermination of the complex, they make the simple animals the only ones capable of living, and thus bring about a return to the primitive.

In contrast to the Darwinians, the Lamarckians see at work an internal shaping force, which, in accordance with plan, creates beings that express that plan. The Lamarckians, therefore, may speak of an evolutionary idea. But the significance they attach to the shaping force is psychological, and so is not controllable by an outside observer. Biology must insist, without qualification, that it shall be so controlled.

THE IDEA OF EVOLUTION

The enthusiasm with which Darwinians advocate the idea of evolution has something absurd in it; and this is not merely because their view of the world, essentially based as it is on physics and chemistry; cannot create the idea of evolution out of these sciences, which are fundamentally opposed to any evolution whatsoever. It is also, and chiefly, because the word "evolution" expresses just the opposite of what it is intended to mean.

It cannot be denied that, in the same breath, Darwinism uses one word in two opposite senses. When it speaks of the evolution of the individual, it means simplification; when it speaks of evolution in the animal kingdom, it means complication.
It is not surprising that the hopeless confusion obtaining at present (and not only among laymen) with regard to fundamental questions in natural science, should be the outcome of this unconscious juggling on the part of Darwinism.

Darwinism, the logical consistency of which leaves as much to be desired as does the accuracy of the facts on which it is based, is a religion rather than a science.

INCREASE IN COMPLEXITY

We turn again to the question, "On what is based the increase in the complexity of animal forms, which in the course of ages has come about upon the earth?"

All of this concerns merely the increase of complexity in the phenotype, but tells us nothing about its increase in the genotype. The genotype can become richer only through new genes arising; and as to this we know nothing.

CHAPTER VIII
CONFORMITY WITH PLAN

If by biology we understand the doctrine of conformity with plan in the world of living things, we shall realise that one of the fundamental inquiries of the science must be into the nature of this conformity. Is the conformity with plan that we can demonstrate in all organisms, inseparably associated with their being? Or is it merely a creation by uncritical analogy with our human life, perhaps incapable of sustaining objective consideration, which sees nothing but causality in all natural phenomena? There has been much in favour of the second view, and more especially the name given to conformity with plan. Instead of seeing in it merely a rule stretching across time and space, men have spoken of "purpose" and "purposefulness" in Nature; and this introduced the idea of Nature as a sort of human being, foreseeing future events and acting accordingly.

But just where conformity with plan is easiest to detect, we can find no trace of any such human-like being. It is advisable therefore to dismiss from biology, for all time, expressions such as "purpose" and "purposefulness." What remains uncontested is the presence of a rule in living Nature, which reveals itself even in the mechanical processes of the organism. The only debatable question that remains is this—"Is there only a mechanical law in the world of living things, or is there also a super-mechanical law, for which we wish to introduce the term 'conformity with plan'?" Are the processes in conformity with plan, which we study in the living world, connected solely with the rules of a mechanical working that has been there from the very beginning, or are they controlled by rules of function embracing not only the working but also its guidance ?

To advance as far as possible by means of the more simple assumption is entirely in accord with the scientific method of thought. But it is not scientific to make of the simpler assumption an article of faith that excludes other assumptions.

IMPULSES IN THE ACTIONS

THE CONCRETE SCHEMA OF FRAMEWORK-FORMING

The body of animals is not merely a machine performing none but mechanical actions; it must perform many that cannot be controlled in mechanical ways. Super-mechanical actions of this kind are always required when framework is formed anew; and the framework already there is quite incapable of this, in spite of all the physical and chemical aids that the body has at its disposal.

The problem of constructing an apparatus capable of dividing itself into two equivalent apparatuses, is technically impracticable. No framework can be so built that it can duplicate itself. By the function of a framework we always understand its action in an outward direction. A framework that dissolves or divides itself no longer fulfils a function,
but loses it altogether. But in cell-division a function is required of the cell-apparatus that shall serve not merely to divide the cell's own apparatus into two halves, but to make these halves duplicate.

RHYTHM

In a melody we distinguish three things—the notes, the sound-sequence, and the beat-sequence. In melody only the last of these is described as rhythm. But it is different as soon as we transfer the word melody into other associations.
If we compare some living process with a melody, the beat—the rate at which the process takes place—interests us quite secondarily; on the other hand, the regular alternation in which thepart-processes release one another, comes into prominence, and is then described as rhythm, although it really corresponds to what we describe as sound-sequence in the melody.

The shape and material properties of the bricks reproduce the peculiar nature of the structural material of a house, and the laws of this must be kept in mind in building. The sequence of construction that causes the house to arise, and with which brick after brick is harmonised in accordance with its special nature—that is the rhythm.

In the development of any structure the same thing can be demonstrated—namely, elementary parts, which are adapted to one another in accordance with their special nature, and a rule, the rhythm, by which the structure arises.

For the building up of a living organism from the germ the impulses have at their disposal numerous chemical structures with complicated peg and socket joints, and their polar tensions. What the impulses themselves must bring in is the building-sequence through their rhythm.

The mistake of all anti-vitalistic hypotheses as to they genesis of the organism lies in their regarding the building-sequence as already given in the material. It is just as impossible for a melody to derive its law from the relationship of the notes (even if the related notes should mutually attract one another) as for the building-sequence of an organism to be deduced from the chemicalaffinity of the germinal elements (i.e. from their peg and socket joints, together with the polar tension).

Now it is true that each member of the chain—i.e. each function-circle—is an independent action on the part of the animal; but the chain itself—i.e. the rhythmic sequence of the function-circles—is a creation of the external world, because the order in which the indicatorsappear depends on associations that are independent of the animal.

Here for the first time we meet with the idea of an external rhythm which enters into competition with the internal rhythm of the animal.

If the several function-circles are fixed as reflexes, the whole life-course of an animal may give the impression of being a process that unrolls automatically. An indicator, such as the prey, attracts the animal, is devoured, and disappears. The indicator " enemy " appears, and repels the animal, whose flight results in the vanishing of this indicator also. This led Loeb to consider the life of an animal purely from the standpoint of physics, as a chain of tropisms, and to transfer the rhythm of animal life entirely to the exterior.

There is an essential misconception here, for the tropisms are not simple physical processes. The appearance of a tropism, which by its nature remains a reflex, necessarily presupposes the presence of an indication. It is true that an indicationcrops up on the life-path of an animal only when a stimulus affects the receptors. But it depends entirely on the structure of these as to which stimulus is taken up and converted into excitation. There is no physical law, proceeding from which we can say that such and such a physical process must become an indication for the animal, while such and such another one will not. Much less dare we assume that some particular object must play a part in the life of the animal also. We can only conjecture that it is an indicator: what indications itgives depends solely on the animal.

The life-path of an animal, which we may imagine as a tunnel of indications, holds only such things as exist through their relations to the animal—those and no others. If we wish to enter into the life-path of an earthworm, for instance, we must not forget that it is composed of earthworm things, and of nothing else.

Nevertheless, the inquiry into the presence of an external rhythm and its effect on the animal is justified. The observer can show that the indicators appear on the life-path in a sequence independent of the animal, and he may ask himself the question, "In how far is an inner rhythm of the animalopposed to the external rhythm?"

In many animals an inner rhythm, consisting of waking and sleeping, strives to fall in with the outer rhythm of the life-path that expresses itself in the alternation of day and night. By raising the threshold during sleep, all indications can periodically be suppressed.

In terms of human thought, the inner rhythm of the animal knows the laws of the outer world, although the animal gets no information thereon through the indications at its disposal. It is this knowledge possessed by the inner rhythm that I have called the "wisdom" of organisms. Of course, there is no question here of knowledge or wisdom in the humansense, but of a "congruity" of the internal processes of the animal with the laws of the external world.

CONGRUITY

A carelessly chosen word may cause incalculable harm to science, if it contain an analogy going beyond what is actually known, and so give to research a misdirection. Such a word is "adaptation." Originally by adaptation was meant only the unshakable fact that all animals are suited to their environment.

But the word contains an analogy with human activity, i.e. of the making-themselves-suitable-to-one-another of two objects A and B. So that the word introduced two sorts of principle, which did not arise from observation of Nature.
Firstly, it is stated that A and B did not suit one another from the beginning, and secondly, that the business of becoming suited requires a certain time.

By the universal adoption of the word adaptation, men of science were compelled to see in the mutual " harmonising" of organisms and their environment observed in Nature a process which is gradually accomplished. Some relations between organisms and their environment are better adjusted than others.

"Congruity" seems to me a term of the kind, since it asserts nothing but the undisputed fact that organism and environment suit one another. The question remains open as to whether the congruity was present from the beginning, or whether it was gradually acquired.
In the latter case, we should be able to discover relations that are more incongruous than others.

As we know, this question has already been decided. There is no "more" or "less" as regards congruity. Congruity is always perfect, so far as the means at the disposal of the animal extend. If all organisms are perfectly congruous with their surrounding-world, there is no such thing as gradual attainment of perfection; the perfection of congruity exists everywhere from the very beginning.

THE THEORIES OF ADAPTATION AND OF CONGRUITY

If we regard the world from the standpoint of the theory of adaptation, then each organism is the product of influences to which it has been exposed for thousands of years. Every object, implement and organism in its environment have their share in the transformations that it has undergone. The media, animals and plants set their stamp on it. Its entire organic and inorganic environment, light and rain, warmth and cold, alter and shape the susceptible protoplasm, until at last it assumes the form, colour and consistency that assure it a permanent place in the world.

Through innumerable "errors" the everlasting "trials" of Nature (which permits all the agencies within it to influence each single organism) lead on towards an ultimate product that shall have achieved the suitable form, making it wholly congruous with the other world-factors.

The Darwinian theory offers only an approximate explanation of this dogma. It points out that the production of offspring is so enormous that if each organism should multiply without restriction, it would soon crowd out all the others.
That is guarded against by the struggle for existence, in which all animals compete with one another, a struggle that makes for balance in the world, but at the same time permits of a finer and finer selection; for only the "best adapted" organisms are capable of survival.

All the physical and chemical agencies are supposed, by their external influence, to carry out the creation of form on a substratum to which no properties can be ascribed other than great power of reproduction and variability. As soon as we presume any tendency whatsoever in the fermentative process to have a goal or give a direction, we are forsaking the Darwinian basis. In thisrespect it is essentially different from Lamarckism.

The direction followed by the shaping is exclusively dependent on external factors. Now animal machines do not consist exclusively of external organs, but also of internal, and these cannot be influenced directly by external agencies.
How are we to imagine the genesis of such organs? Is there a struggle for existence even among the organs?

It is obvious thatany machine must fall to pieces if its wheels, instead of cooperating according to the same plan, work against one another, and try to increase at one another's expense. But in no circumstance must there be a plan at work, or the whole doctrine would collapse.

To Nature, however, it is more important that her creations should not fall asunder, than that a theory, however elaborate andingenious, should come to naught. And so she has constructed all animal machines in full accordance with plan. In all organisms the various organs do not become adjusted to one another by mutual wearing away—a method that no machine could bring off—but, from the very outset, they are quite perfectly "congruous" with one another.

If we proceed from this undeniable fact, and conclude from it that the like congruity also exists between the organism and its surrounding-world, the world takes on a totally different aspect. Each organism is then no longer an impression of the universe, but, like any machine, is inserted in a perfectly definite circle of activity and congruous with the objects, implements and organisms of its surrounding-world. It is not the environing world that has given the shape to the organism by an influence from without; an inner plan ever causes to arise from out the germ-plasm fresh organisms, which are in harmony with their surrounding-world.

This plan is itself the constructor of the organism, and comes to expression in the protoplasm by the help of the impulses, which it forces to the work of shaping.

There are as many plans as there are organisms. The plan of the individual never embraces the whole universe, but just a small, sharply delimited portion thereof. The plan of the individual includes more than the shape of the organism that it creates, but never more than the organism's surrounding-world. It never creates this surrounding-world, but, through selection, binds it, by all its pegs and sockets, into a unified casting-mould, which intimately embraces the organism and its receptor and effector functions.

THE PLANS

The peculiarity of every plan that lies at the back of an organism consists firstly in this, that it at one time finds expression in influencing the shaping of the organism, and secondly, that it is manifest in the selection of the indicators and their combination into an indication-tunnel.

The first half of the plan forms in the animal's body the pegs and sockets that fit into those of the indicators. The second half itself selects and takes over thepegs and sockets already present in the indicators, and, by fitting them in with the sockets and pegs it has formed in the organism, it connects them all into a unity, the indication-tunnel (or surrounding-world) of the animal.

Perhaps the presence of the first half of the plan—that which governs the shaping of the animal—will be accepted without contradiction: whereas the second half—which concerns the selecting of the indicators—may excite question. So long as we are unable to rid ourselves of the idea that the plan is lodged, spatially, in the germ of the organism, we are not likely to credit it at the same time with the power of having such a knowledge of the universe as would enable it to cut out there from just the piece that suits it.

ORGANIC AND INORGANIC ACTIONS

Both machines and organisms show two kinds of actions which are essentially different from one another, (1) the action of genesis, and (2) the action of function. But the action of genesis in the organism (to which regeneration of destroyed tissue is to be reckoned) is direct, whereas that of machines is, without exception and in its very nature, indirect, since it proceeds from the actions of its constructors, which are conditioned by indications. The function-action of the organism is always indirect, because it is built up on indications, whether these be fixed once and for all by the framework that makes the selection, or, as in plastic actions, are conditioned by the newly formed construction of the machinery.

TRIAL AND ERROR

Undoubtedly it is of very great help in biology to seek out typical examples, because only through such can we get visual representation. But we must carefully analyse the typical case down to its ultimate elements, if it is to serve as an explanation of other cases.

TROPISMS

J. Loeb, the founder of the doctrine of tropisms, comes from a far too exact school of physics ever to try to explain the observed life-processes by the aid of psychological hypotheses. He never seeks an explanation through the mind of what takes place in space and time in full concreteness.

Nevertheless, he is nearer to biology than are other physicists. For him the world does not consist of a haphazard dance of atoms, but is filled with mechanisms and machines, which fit exactly into one another. Loeb is much too much of a professional as regards mechanical problems ever to recognise the doctrine of adaptation. No one could ever persuade him that a motor-car could develop out of a bicycle.

Loeb, judging animal-machines from the same point of view, looks for the factor in the external world that shall do this for them. He finds these in the "directed" forces of the external world, and primarily in light and gravity, and accordingly attempts to explain the directed movements of animals by two factors (1) the animal's locomotor apparatus and (2) the direction-giving agent outside.

In this way he has succeeded in explaining a number of kinds of animal movement as "tropisms" (i.e. a movement directed from without). Heliotropism, phototropism, geotropism, rheotropism, etc., have become useful shibboleths to include a great number of similar movements in very different animal groups.

Unfortunately Loeb gives his case away, as soon as he comes to speak of the human soul, the activity of which he undertakes to explain through the chemical processes of the brain. If he repels the encroachments of the psychologists in explaining the mechanics of the body, the psychologists have equal right to set aside as amateurish his mechanical explanation of the life of the mind.

THE SENSED-WORLDS OF HUMAN BEINGS

If we wish to apply to human beings what we have learnt from biological consideration of animals, it is of the first importance to choose the right standpoint, permitting us to view not merely human beings themselves, but also their surrounding-worlds.

If we mount up in a captive balloon, human beings at first recede from us, and then, at a certain point, this changes into their reduction in size. They seem nearer to us again, but very much smaller. Let us choose the moment when they have assumed the size of a large insect, such as a dragon-fly or a grasshopper. Now at our leisure let us consider these little creatures which occupy but a tiny action-circle in the vast horizon. We see the rivers, as on a map, branching away like blue ribbons; the mountains have become mere mounds, and the cities playthings. Within these the homunculi move to and fro.

Beginning with the heavens, the physical process of decomposition has gradually invaded the whole of the world as-sensed. If we assume from the beginning that there is no conformity with plan hidden behind natural phenomena, but always just the same mathematical calculation, complicated, it is true, but utterly stupid, then all interest in these things must die out.

A sort of rot has set in in the sensed-worlds, and everything within them has been handed over to disintegration. Since Darwin's day, we see not only the inorganic objects, but also the living things in the sensed-worlds of our fellow-men, fall to pieces. In the majority of sensed-worlds, animals and plants have become nothing but assemblages of atoms without plan. The same process has also seized on the human being in the sensed-worlds; even the subject's own body is just an assemblage of matter, and all its manifestations have become reduced to physical atomic processes.

If we look downattentively from our balloon on this ever spreading epidemic in the worlds-as-sensed, we get the impression of a dangerous infectious disease. The joy in the search for new indications has quite slacked off. What is the use of searching, if we know beforehand that the whole thing is just a dance of atoms ?

On the other hand, we perceive an alarming reduction in indications. The world of most people whose calling does not oblige them to pay regard to Nature, is hopelessly impoverished. Instead of the thousand different plants and animals, we see a deadly, monotonous repetition of the same tree with the same indications of "green" and "high," and among animals even the dog and the horse are scarcely distinguishable as regards their indications. Almost everything else is simply and monotonously "animal."

It is not surprising that landscapes differ from one another merely quantitatively. The most famous view-points are always those from which one can see "as much aspossible." We are able to see "many" mountains or "many" rivers, it is true; but fundamentally they all look alike.

Such people, dwelling in the most dreadful wilderness, where only a few of the commonest objects repeat themselves again and again ad nauseam, are called "rich," as though in mockery; although in comparison with any peasant or shepherd, they are as poor as beggars.

This regrettable laying-waste of the worlds-as-sensed has really arisen from the superstition started by the physicists, which would induce each person to consider as the universe his own small and often inferior sensed-world, a universe composed of nothing but points revolving round one another without plan.

THE COMMUNITY AS AN ORGANISM

If we mount up still higher in the balloon, there become defined below us the boundaries of a small community being, which we are able to survey in its entire expanse.

We now employ the method of geographers, who are able to construct an entire portion of the world on their mapping-table—the method ofmacroscopy, which, unlike microscopy, makes the details subordinate to the framework of the whole—and we try to detach carefully from the substratum everything that belongs to the human community-being, so that we may spread it out on a small scale on our work-table.

Here we see the fundamental difference between the animal community and the human. The human community has no sexless individuals, dedicated exclusively to the affairs of the community, and therefore grown to their tools like the workers and soldiers of the ants. All human beings can free themselves from their apparatus, their clothes and their dwellings, and still remain capable of exercising the functions of the individual life and of reproduction. It is only among human beings that we can separate the community and the people.

The community shows human beings as associates in work; the people shows them as founders of families, devoting themselves to reproduction and the rearing of children. Each human being has a twofold task assigned him, as member of the people, and as worker for the community. The community requires that the people shall provide it with suitable workers; the people demands of the community that it shall create for it suitable conditions of life. And thus both complete themselves, though they are essentially different from one another.

The fact, so characteristic of human beings, that they belong both to community and to people, has led to manifold misunderstandings. Men have tried to raise to the position of the ideal of the community the ideal of the people, which may be formulated as liberty, equality and fraternity; whereas the community ideal cannot read other than compulsion, inequality and subordination. The reconciliation of these two antitheses is the chief task of humanity.