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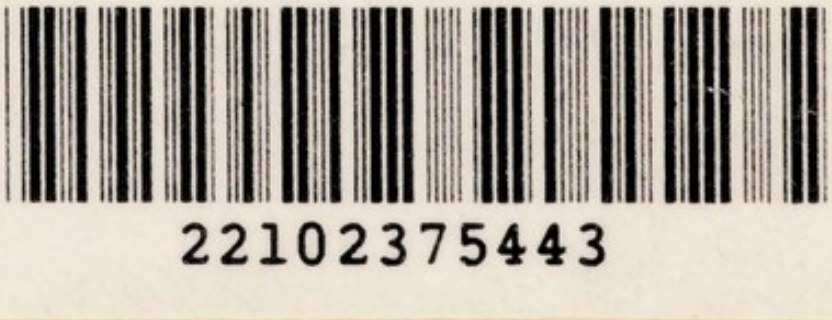

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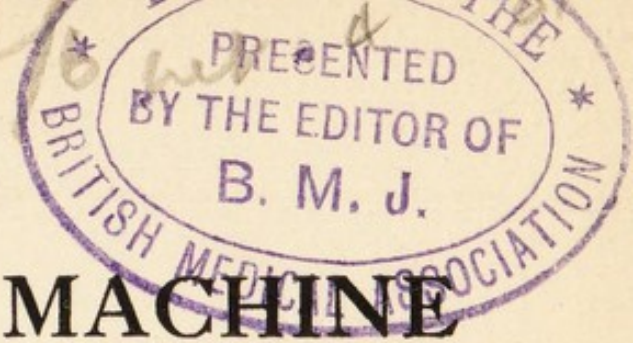

MAN NOT A MACHINE

A STUDY OF THE FINALISTIC ASPECTS OF LIFE

BY

EUGENIO RIGNANO

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Editor of "Scientia"
etc.

WITH A FOREWORD BY

PROFESSOR HANS DRIESCH

LONDON:
KEGAN PAUL, TRENCH, TRUBNER & Co. Ltd.
BROADWAY HOUSE, CARTER LANE, E.C.
1926

Printed in Great Britain by
R. I. SEVERS, CAMBRIDGE.

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FOREWORD

My friend Professor Rignano has asked me to write a few words of introduction to his book *Man Not a Machine.* I do so without hesitation, for I believe this to be a most important and valuable work. His analysis of all classes of biological facts is excellent, and I regard it as particularly important that he has demonstrated finalism even in the process of metabolism. The chapter on metabolism is, in fact, the clue to all that follows.

I am sure that Professor Rignano's clear and thorough interpretation will lead many of his readers to an acceptance of the vitalistic point of view.

I do not, however, mean to say that I accept Professor Rignano's theoretical account in full. As I have said in my *Science and Philosophy of the Organism,* Volume II, I am not of the opinion that

the introduction of a specific kind of vital energy solves the problem. What I call 'entelechy' has nothing in common with Professor Rignano's 'energetic principle of specific accumulation'. But this difference in our points of view is not of great importance.

The essential fact remains that both of us are led to the conclusion that a mechanistic explanation of life is absolutely impossible. Each of us follows his own way of thinking, but the chief result of our thought is the same.

HANS DRIESCH

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February 24, 1926

INTRODUCTION

The long debate between vitalists and mechanists, in attempting to give an explanation of life, cannot lead to any conclusion unless that fundamental characteristic common to all vital phenomena of presenting a *purposive, teleological,* or *finalistic* aspect in their most typical manifestations, is first thoroughly examined. This the writer proposes to do in the present book.

For this purpose we shall pass rapidly in review, in the most succinct and schematic way possible, the various manifestations of life, divided into nine categories or sections, beginning with the most simple biological phenomena and going on to the more complex.

I

Finalism of the Most Elementary Physiological Phenomena

Assimilation and Metabolism

Even in the most elementary and general manifestations of life we have to do with purposive phenomena, quite distinct from all the phenomena of the inorganic world.

Assimilation is a *selection*. The living substance, which continually destroys itself in its phase of functional activity, and continually reconstructs itself in its subsequent phase of reparative rest, *selects* from the very complex mixture of chemical substances dissolved in the nutritive liquid exactly those compounds or radicals capable of reconstructing it in the same specificity as before. And, as *selection*, this process has a marked *purposive* aspect.

While in the formation of crystals there is but a reciprocal attraction of molecules, all equal to each other, which leave their places in the solution to pile themselves one upon another—a passive process, therefore, of deposition—in assimilation we have to do with *an active process of synthesis or reconstruction* by means of materials selected *ad hoc* and different from the substance which they are called upon to reintegrate.

The living substance, in part destroyed or disassimilated in its preceding phase of functional activity, seems, therefore, to ' have the purpose', in its assimilating phase, of repairing itself and regaining its former condition. Nothing of this kind is observed in the inorganic world, where chemical substances, when disintegrated or transformed into other compounds, *do not present the least tendency to reconstruct themselves through an active process of their own.*

Loeb himself is obliged to admit

that in the living substance there is "some specific synthetic mechanism" which is specifically different for the different cells of the various tissues. But this 'synthetic mechanism', the function of which is not only to synthesize complex compounds, but to reconstitute precisely those compounds which were destroyed in the disassimilating phase immediately preceding, *must evidently depend on the specificity and the modalities of this same disintegrating process.* As the disassimilating process changes with different external stimuli, and as a consequent change takes place in the quality of the living substance destroyed and requiring replacement, the synthesizing mechanism must also change correspondingly, *so as to reconstruct exactly and exclusively what has been destroyed.*

The synthesizing mechanism, in other words, must bear the same relation to the disintegrating process as a medal to its die. When the die changes,

the figure on the medal changes in exact correspondence; when the disintegrating process changes, the integrating mechanism must change in exact correspondence.

It is as if the disintegrating process itself changed direction while remaining identical in every other way, and transformed itself into the corresponding synthesizing mechanism. Nothing like this is observed in inorganic matter, in which every process of composition or of synthesis depends exclusively on the chemical properties of the materials which are in contact and on the physical environment which surrounds them, *but never on the character of the preceding process of disintegration which produced these materials.*

If we pass from simple assimilation to that process of alternate assimilation and disassimilation which bears the name of metabolism, we meet another property of life which is never presented by any process in the *natural* inorganic world (that is, without man's

artifice), namely: the ability of this metabolic process *to maintain itself or settle back in a state of 'stationary' (stable) equilibrium.*

It is not the quality or kind of chemical transformations that take place in metabolism, nor the fact that they occur otherwise than in the laboratory (for example, at low rather than high temperatures), which differentiates metabolism from any physico-chemical process in the inorganic world; but rather that it is, in its deepest essence, *a process in stable equilibrium.* It does not take place except in a stable state; and if this state is interfered with by disturbing agents it tries (as we shall see further on in considering the phenomena of new adaptation) to eliminate or neutralize the disturbing cause, or else to involve it in its own process, and thus settle back into the former stable equilibrium or into a new stable equilibrium.

In inorganic nature, before it is touched by man's artifices, *we never*

meet any process with a similar tendency to maintain itself or to settle back into a state of dynamic stationary equilibrium, nor do we ever meet any process that is in such a state. Certainly the engines which move the machinery of a factory, the boiler, and the water which flows to a turbine, are mechanical, or thermodynamic, or hydrodynamic systems all in a state of stationary equilibrium; but the engineer knows what a number of contrivances are necessary to accomplish this end. So, too, the flame of a candle, to which many would liken the torch of life, is maintained in a state of chemico-dynamic stationary equilibrium only by the wick, which has been made by man in such a way as to maintain a constant flow of melted wax through it.

Thus (to sum up) the teleological or 'finalistic' aspect of metabolism is evident in: (1) *its tendency to remedy immediately organic destruction* by a corresponding assimilation which reproduces identically the part destroyed,

both qualitatively and quantitatively; (2) *its tendency to remain in a state of dynamic stability*, different from any condition in the inorganic natural world, but similar to the state in many machines or artificial processes where man imparts the stability for purposes of his own; (3) *the tendency or property of autoconservation*, which it thus imparts to every fragment of life and to the organism as a whole.

The most casual observer must be struck by the difference between the living human organism, which maintains itself almost unchanged during the thirty years of maturity between the ages of twenty-five and fifty-five, and the dead body which is so greatly transformed in less than twenty-four hours. Why is there so substantial a difference in behaviour if, in the living organism, there are in action only those same physico-chemical agents which bring the corpse to such rapid disintegration ?

In presence of these facts which so

clearly distinguish the phenomena of life, even in its most general and elementary manifestations, from all the phenomena of the natural inorganic world, we must ask whether it is in keeping with the true scientific spirit to persist in denying that these facts present something substantially different from the ordinary phenomena of a purely physico-chemical nature, and to continue to contend that physico-chemical laws alone are sufficient to explain them. Is it not more in accord with sound positive method to enquire whether, by assuming a new form of energy—always obedient to the general laws of energetics, but endowed with well-defined elementary properties different from those of any form of energy in the inorganic world—it may not be possible to 'explain' these properties of life, which seem so many 'mysteries' as long as we obstinately try to explain them by physico-chemical laws alone?

It is this that the present writer

has attempted to do in his two books, *On the Inheritance of Acquired Characters* and *Biological Memory*, by the hypothesis of specific accumulation, which seems to appertain properly and exclusively to the energy which he regards as the basis of life. This hypothesis assumes a reciprocally univocal correspondence between specificity of substance, alternately accumulating and disintegrating, and specificity of energetical activity, alternately charging and discharging. A further hypothesis is made relative to the mode of production of the nuclear discharges during the so-called state of functional repose, such that the disintegrating process itself is transformed into the corresponding synthesizing mechanism. These two hypotheses afford the desired explanation of those characteristics and properties of assimilation and metabolism which belong peculiarly to life.

For a further consideration of this subject the reader must be referred

to the works above-mentioned, and especially to the fourth chapter of *Biological Memory*, which deals with the properties of the peculiar form of energy assumed by the writer as the basis of life.

These hypotheses and the explanatory results reached by them are mentioned here only to furnish a new proof that it is unscientific and a denial of irrefutable facts to persist in rejecting every peculiar characteristic of life, and that a prejudiced refusal to take new paths is a confession of intellectual sterility. To seek new hypotheses regarding the energetic qualities of some other form of energy at the basis of life, and to submit these new hypotheses to the test of facts is—even though the first attempts achieve but little success—to follow those methods which have always resulted in the greatest and most fruitful conquests of human knowledge.

We shall be the better convinced of

this the further we advance in the examination of the other teleological aspects of life, which are the more or less direct consequences, and the more or less complex manifestations of those elementary and general aspects which we have just reviewed.

II

Finalism of the Generative and Regenerative Phenomena

The faculty of reproduction or self-construction possessed by organisms has always appeared a fundamental characteristic of life, to which no phenomenon in the natural inorganic world has the most distant resemblance. Even the machines made by man lack this power, for no machine has in itself the capacity of producing its own organs and its own elements.

Therefore, even if the organism could be explained as a physico-chemical 'machine', there would still remain to be explained the most fundamental thing—how this machine has constructed itself.

The purposiveness of the ontogenetic development is too evident to be denied. It results from the convergence of manifold morphogenetic

activities to one sole end, that is, to the formation of a marvellous functional unity, every part of which serves to maintain the life and guarantee the well-being of the whole.

The embryo in its development manifests at every stage a 'harmony of composition', as Driesch calls it, which has a touch of the marvellous: parts and elements of an organ develop independently, but when they have finished their development they are found to fit together perfectly like the parts of a machine, and the one so answers to the other that they unitedly form one complex organ. Thus the mouth and the intestine of the sea-urchin begin their development at two points distant from each other, and develop independently, but as they grow the one moves towards the other, so that when the development is terminated they fit together perfectly and constitute a single canal.

Ontogenetic development evidently aims at a predetermined end; its pur-

posive aspect is evinced by the fact that the organism forms in itself what will *later* serve for its conservation. The formative activity seems endowed with a 'prevision' of future needs; it creates the organ of sight in the embryo while still in the maternal womb, although this organ will serve it only in the extra-uterine life; it creates the stomach and the digestive apparatus, useless to the embryo which still is nourished by the maternal blood; and the lungs, though no respiratory function is yet necessary.

Ontogenesis thus seems 'marshalled' by some occult intelligence or 'entelechy' in the same way that the construction of a machine and the direction of its work is presided over by the mind of the engineer.

The direction of ontogenetic development toward a predetermined end is also evidenced by the fact that the embryo overcomes early disturbances which might deflect it from its course. Such disturbances would certainly de-

flect a purely physico-chemical process; the embryo, however, reacts against them so as to get back into its usual path and resume its normal development.

The phenomena of regeneration also demonstrate this tendency of the organism to arrive at its predetermined end at any cost, especially those phenomena of so-called *Rückbildung* or *Umdifferenzierung*, in which the remaining part loses its differentiation, becomes a heap of undifferentiated cells, and begins anew the process of formation of the new organs.

We will not take time to discuss here the phenomena of isolation and displacement of blastomeres, of the fusion of two or more blastulæ or gastrulæ in one embryo, and the like.

What do the ultra-mechanists do in presence of these distinctly teleological manifestations of the generative and regenerative processes? They direct all their efforts to an attempt to prove that given chemical substances exercise

a morphogenous action on particular developments, hoping to conclude triumphantly that the entire series of morphogenous phenomena, constituting the ontogenetic development, may be explained completely and exclusively by physico-chemical action.

But in this attempt they have mistaken a mere *release* of morphogenous activities already potentially in the developing embryo for a genuine morphogenous action. This could easily be proved if space permitted.

But even if they should succeed in this task, they would still need to explain the purposive aspect of their long and complicated series of purely physico-chemical actions—a purposive aspect which physico-chemical processes never present in the natural inorganic world.

In view of the facts examined in this second section, which so clearly distinguish the generative and regenerative phenomena from all the phenomena of the natural inorganic world, one

seems justified in asking again whether it is in keeping with the true scientific spirit to close one's eyes to the very marked teleological character of these phenomena, and to persist in affirming that they present nothing inexplicable by the common physico-chemical factors active in the inorganic world. On the contrary, is it not in accordance with sound positive methods of research to investigate the possibility of accounting for these phenomena of generation and regeneration by some new hypothesis in accordance with the most fundamental truths of modern science ? Renouncing a purely mechanistic or physico-chemical explanation, we must determine whether these phenomena cannot always be explained, from the energetic and deterministic point of view, by the assumption of a new form of energy peculiar to the realm of life.

Now the property of specific accumulation assumed above as peculiar to the form of energy at the basis of life (and

which has already explained to us the fundamental properties of assimilation and metabolism), together with our centro-epigenetic hypothesis of development, are more than sufficient to furnish us with an energetic and deterministic explanation of all these generative and regenerative phenomena.

In the author's two books referred to above he has attempted to show how these two hypotheses dispense with the need of recurring to 'entelechies' or other similar metaphysical or mystical entities, which imply the renunciation of any scientific causal explanation.

We have thus succeeded in solving the three fundamental dilemmas of ontogenetic development which have so long defied the biologists, viz. preformation or epigenesis, preformistic germs or non-representative germinal substances, and nuclear somatization or qualitatively equal nuclear division. We can also account for the fundamental biogenetic law of the

ontogenetic recapitulation of phylogenesis; for the mechanism which transmits acquired characters; and for the notable analogy, brought out by Hering and Semon, between the phenomena of development and mnemonic phenomena properly so-called. For a more detailed consideration of these points the reader must be referred to the book *On the Inheritance of Acquired Characters, Hypothesis of a Centro-epigenesis,* or to the second and third chapters of *Biological Memory,* which give a summary of it.

III

Finalism of the Morphological and Physiological Phenomena of Pre-established Adaptation

At the moment the organism enters into contact with the external world, and before this world has had any possibility of exercising any formative action on it, the organism is already equipped with all the organs, and already capable of all the functions and activities which fit it to its environment. In this pre-established adaptation we again find evidence of purposiveness — a purposiveness which is in strict dependence on the ontogenetic purposiveness already examined.

With regard to every organ, every function, every vital activity with which the organism is endowed from the very moment it begins life outside the egg or the maternal womb, the question, Of what use is it?—analogous to the

question the engineer would ask about every element or function of a machine —always receives an adequate reply.

What has been the solution that the mechanists have attempted to give of this morphological and physiological preadaptation, the purposiveness of which was too evident for them to deny? They have thought to find the explanatory key in Darwin's natural selection, which owes its great and, originally, almost undisputed success to its attempt *to explain in a non-purposive way these phenomena of pre-adaptation.*

Here we cannot even succinctly examine all the evidence and all the arguments that prove the absolute insufficiency of the Darwinian explanation which has been brought to its climax by Weismann. It is absolutely unthinkable to entrust the construction of an organism *to the mere play of fortuitous variations,* in which the organism would take no active part, and which would come to it as a gift

from heaven, even though this chance play were aided by an incessant, rigorous, and most active selection. For the construction of an organism means the construction of a mechanism more complicated and more perfect than our machines, one which answers a well-defined purpose, and which represents the most absolute antithesis to processes left to pure chance.

The Darwinian theory primarily attempted to explain those phenomena of pre-established adaptation which are principally *morphological.* At that time there was little or no knowledge of *physiological* adaptation, which is even less explicable by the accumulation of purely fortuitous variations, even though sifted by natural selection. And in these physiological phenomena of pre-established adaptation the purposive aspect is even more prominent, for they have the purpose *of maintaining the organism in its stable physiological state, or of bringing it back to that state,* in spite of variations that may take

place in its environment. Thus, for example, if the quantity of carbonic acid in the blood passes a certain limit, special nervous cells situated in the respiratory centre react and excite the corresponding respiratory muscles, the rhythm of respiration is accelerated, the respirations become deeper, and the excess of carbonic acid is expelled, so as to re-establish equilibrium in the blood.

No physico-chemical process in the natural inorganic world presents anything in the least like this, for such processes are conditioned by their environment instead of reacting to it so as to maintain themselves unchanged.

The tendency of the elementary metabolic processes to maintain themselves in a stationary condition explains at once the same tendency in the organism as a whole, since its entire activity results from the totality of the single metabolic cellular processes. This, however, does not diminish the ulterior purposive aspect of the various

physiological procedures by which the organism succeeds in satisfying its tendency to stable equilibrium, inasmuch as the organism finds these procedures co-ordinated and ready to function as soon as occasion demands.

In view of the facts of pre-established adaptation, morphological and physiological, and of the absolute inability of Darwinian selection to explain them adequately, we must again ask ourselves whether it is in accordance with the true scientific spirit to force them, in spite of themselves, into the category of purely physico-chemical processes. Is it not preferable to attempt an explanation elaborated especially for them, which shall above all account for that purposive aspect which chiefly distinguishes them from the essentially non-teleological processes of the inorganic world ?

The explanation of pre-established adaptation is in part implicit in our hypotheses, which account for the phenomena of ontogenesis and the

transmission of acquired characters. In fact, all these morphological and physiological pre-established adaptations are, evidently, but the simple reproductions, by way of hereditary transmission, of new adaptations which have previously appeared in the course of phylogenetic evolution. So that in order to obtain their complete explanation, we want now only to explain these phenomena of new adaptation, and to this the following section will be devoted.

IV

Finalism of the Morphological and Physiological Phenomena of New Adaptation

While the purposiveness of the morphological and physiological phenomena of pre-established adaptation is self-evident, the purposiveness of the phenomena of new adaptation seems less evident to many. It is, indeed, denied by those mechanists who attempt to bring these phenomena into the categories of the natural inorganic world, in which every physico-chemical process comes into equilibrium with new energetic environmental conditions as these arise.

But a purposive aspect subsists in these phenomena of new adaptation, for they all have, directly or indirectly, as their end *the stability of some physiological process*. They achieve this end either by restoring with a minimum of

accessory modification—transitory or permanent—the old stable state which has been disturbed by the new environment or agent; or else, when this restoration is no longer possible, by settling into a new physiological state, *which in its turn is also stationary*. It seems as if the vital process cannot continue unless it succeeds sooner or later, in one way or another, in acquiring or reacquiring physiological invariance of some kind.

On the contrary, nothing of this kind happens in the physico-chemical processes of the natural inorganic world, which, though they remain continually in equilibrium with new environmental energetic conditions, never tend *spontaneously* to place themselves in a stationary energetic state, nor to do everything possible to maintain themselves in it when disturbing agents intervene.

To this category of new adaptations belong all those substances or structures which cells, tissues, or organs produce

to shelter or defend their vital processes from disturbing agents. Thus, under too intense solar light which is injurious to protoplasm, the skin darkens in defence. Under the action of destructive external agents the animal skin thickens. The epidermis of leaves transported into too warm and dry a climate becomes more impermeable to evaporation. Special new structures are produced in bones when badly set by the surgeon, and in the stalks of fruits made heavier artificially, as a means of resistance to pressures or tractions which might threaten the vital processes. The classical experiments of Dallinger and Davenport have proved that infusoria can become habituated, little by little, to high temperatures which would kill any individual not acclimatized. Fresh water amœbæ and infusoria can be gradually habituated to live in water so salt that it would at first have killed them.

But the most characteristic phenomenon, which may be said to

represent and sum up all the phenomena of new adaptation, is the formation of antitoxins. Every toxin, whether mineral or produced by bacteria, that invades the organism, causes the organism itself to produce precisely and exclusively that antitoxin which is capable of neutralizing its effects.

Whence does the living substance derive this marvellous property of persistence, this capacity for defensive reaction against all that threatens it, this inherent automatic 'healing force of nature', which has so distinct a purposive and providential character, and which so clearly differentiates living matter from brute matter? Nothing like this ever happens in any physico-chemical process of the natural inorganic world, where it would be meaningless to speak of such concepts as 'injurious agents', 'disease', or 'healing force', all of which, and especially the last, imply *an activity of resistance* to disturbing agents, which is absolutely wanting in non-living

matter.

We cannot enter into fuller details here; it must suffice to point out that these properties of persistence, resistance, automedication, etc. are derived from the tendency to remain in some stationary condition; which tendency cells, tissues, and organisms derive from the same tendency inherent in the very nature of the metabolic process itself.

Living protoplasm, disturbed in its normal metabolism, *has no rest* until it succeeds in re-establishing the old, or in producing a new stationary metabolic process. As an inevitable consequence of losing its stability the metabolic process passes rapidly through successive assimilative and disassimilative phases, all different from each other, with a corresponding chaotic production of different substances, till among these it fortuitously produces one capable either of neutralizing the disturbing agent, or of bringing about a new metabolism which includes among its elements this very agent,

which thus ceases to be a disturber. With this return to a stable metabolic state, when an unvarying process is re-established, the continuous production of new substances ceases *ipso facto*, and all that continues is the production of the new substance which fortuitously succeeded in bringing back the organism to physiological stability. The production of this new substance, which continues in excess of the quantity needed to neutralize the disturbing agent, gives rise to the phenomenon of immunization and makes possible curative treatments with sera.

This process has been compared by Conklin and Zur Strassen (by the latter under the name of ' over-production of opportunities ') to the over-production of movements and to the process of ' trial and error', by which the majority of behaviorists, and especially Jennings, have sought to explain those suited movements of both higher and lower organisms, which we shall examine in the next section. The tendency

of every vital process to achieve a stable energetic state is carried out in this case by ' selection '—that is, by the transformation of the fortuitous into the permanent—of those conditions, external and internal, which make possible the persistence or reconstitution of physiological stability.

It would be easy to prove that this explanation also accounts for the specialization of functions and the division of labour—phenomena and concepts unknown in the natural inorganic world—which have gradually been produced in the different parts of the organism in the course of phylogenetic evolution. This specialization of function by the various organs, tissues, and cells, fixing and consolidating itself during the individual life through the continual increase of the corresponding specific mnemonic accumulations in the nuclei, gradually diminishes the faculty of new adaptation possessed by young tissues and cells, and produces ' old age ' in these

tissues and cells and consequently in the whole organism formed by them; and this 'old age' inevitably leads to the death of the organism itself. But we must pass on to the conclusion to be drawn from this section, which is similar to that of the preceding sections.

Instead of closing our eyes to reality and obstinately repeating that nothing purposive is met with in the phenomena of new adaptation, and that they can be wholly explained by the properties of dead matter, it is more in keeping with a sound scientific spirit to determine what all these different phenomena have in common and what differentiates them from inorganic matter, so as to explain them with some special hypothesis of life. This is the only method from which fruitful results can be expected.

V

Finalism of the Behaviour of the Inferior Organisms

We shall now be able to proceed more rapidly, because the purposiveness of the phenomena which we have still to review becomes more accenttuated as we progress from the elementary phenomena of life and those that are strictly physiological, and gradually approach psychical phenomena, properly so-called.

The behaviour of even the lowest organisms is substantially differentiated from that of brute matter; an animal moves by its own inward forces, it is autonomous in its movements, and while it lives it never abandons itself passively to the play of external energies, like a piece of wood left to the mercy of the waves.

Sufficient proof that their behaviour has a distinct and undeniable purposive

aspect is given by the simple observation that the sole aim of behaviour is to maintain the animal in its environmental optimum, or to bring it back thereto as soon as the animal finds itself in unusual environmental conditions.

Thus the infusorium *Paramecium* at every increase or diminution of temperature reacts so as to maintain itself within those limits which represent its optimum. *Euglena* does the same in relation to the intensity of its environmental illumination. Oysters and actiniæ, exposed to the air, close themselves up—behave, that is, so as to preserve unvaried their own suited environmental humidity. Environmental invariance also includes the position of the organism in respect to the force of gravity; hence the tendency to preserve or re-establish the animal's accustomed support or its normal position. Thus the amœba, brought up from the bottom of the aquarium, seeks with its pseudopodia some solid

body on which to rest. The starfish when turned over tries to right itself; the actinia *Cerianthus* does the same when placed with its head down in a vertical tube of water. We could multiply similar examples at pleasure.

The mere fact that there exists for organisms such an environmental optimum substantially differentiates them from any physico-chemical process in the natural inorganic world.

Evidently the attempt made by organisms, even the lowest, to avoid any change which would remove them from their optimum—and the optimum environment is only that which is habitual—is but the consequence of their tendency to maintain themselves in their physiological stationary state, from which tendency their capacity of new adaptation is also derived. Instead of reacting to the disturbing agent with the metabolic production of some counter-agent which might neutralize or destroy it, the organism in this case reacts by avoiding it. Nuclear dis-

charges are produced which impart to the fibrils of the protoplasm certain contractions and distensions fitted to remove the animal to a distance from the threatened disturbance.

That the two processes, the metabolic production of antibodies and the production of movements of avoidance, are fundamentally of the same nature is proved by the analogy between the phenomena with which these two processes begin. In the one case there is an over-production of substances, and in the other case an over-production of movements, followed in both cases by the animal's 'selection' of the reaction fortuitiously successful.

Jennings above all others has observed and described these phenomena of 'avoiding reaction' and of 'trial and error' in unicellular and other inferior organisms in an eager and penetrating manner unclouded by mechanistic prejudices.

This system of 'trial and error', however, only comes into play when *quite*

new disturbing circumstances are presented. By the repetition of the same disturbance again and again, and thanks to the fundamental mnemonic property of living substance, a mnemonic association is established between the initial impression or 'sensation' produced by the disturbing agent, and those movements which enabled the organism to avoid it. In the end these reactions are produced immediately without tentative movements of any sort as soon as the same disturbing agent presents itself. The animal thus 'learns' to adapt its movements to changing external circumstances.

It is now definitely proved that this mnemonic learning takes place in inferior organisms devoid of a nervous system, and even in the unicellulars themselves. The behaviour of the infusorium *Stentor*, stimulated by Jennings with carmine, shows what profit this little unicellular animal has been able to gain from preceding unsuccess-

ful attempts.

Now, in this learning by experience through memory, originate the first rudiments of what is called intelligence in the higher organisms. But in regard to intelligence the most pronounced mechanists are the first to declare (in order to save for their theories at least the vital phenomena of a physiological nature) that this lies completely outside the sphere of a purely physico-chemical explanation.

Faced with these typical examples of purposive behaviour in inferior organisms, and of purposive behaviour that treasures experience, what have the mechanists set forth in opposition ? Nothing but the simple theory of tropisms, advanced and worked out especially by Loeb, which compares organisms to mechanical toys, but which shows itself quite incapable of explaining the variety, the originality, and the evident purposiveness of animal behaviour, even in the lowest organisms. These mechanistic theories of tropisms,

which do not scruple to misrepresent facts in order to win acceptance, have only served to prove the complete blindness that may fall upon even distinguished observers and experimentalists when they persist in preconceived ideas and conceptions which reality rejects in the most absolute way.

VI

Finalism of the Reflexes and Instincts

The purposive aspect of reflexes, especially in the higher organisms, is so pronounced that they, more than any other manifestation of life, have given biologists the impression that the organism is a ' machine', in which every smallest element is carefully studied so as to co-operate with all the others in fulfilling its functions.

But in their somewhat too hasty enthusiasm for this comparison the mechanists have forgotten that every machine is constructed *for a given end*, and that it presupposes a mechanician who has designed and constructed it.

Our theory, on the contrary, does not require any such mechanician, thanks to the elementary fundamental properties which it postulates for life. Our theory not only appropriates

Jennings's 'trial and error' theory of the behaviour of animals; but penetrates further into the inner nature of this behaviour by admitting in the metabolic process, and consequently in the entire organism, a tendency to preserve its own stable state. Without this tendency 'trial and error' behaviour itself remains unexplained, because 'trial' implies an end to be gained. Our theory is completed by the mnemonic property attributed to living substance, which fixes into specific accumulation the trial that has been successful and therefore 'selected', and which by repeated reproduction ends in becoming 'mechanized' in the form of a reflex. In this way mechanician, designer, and constructor of the organism-machine, are dispensed with.

There is no escaping the dilemma: if we hold that the organism is a machine in which only physico-chemical forces are active, we must then grant the 'clock-maker' of Voltaire, who

has designed and constructed this delicate and perfect mechanism; or if we do not wish to grant this creator, we must then have recourse to some fundamental property of living substance capable of taking his place.

The same holds, a fortiori, for the instincts, from the most simple to the most complex. They arose phylogenetically as non-mechanized behaviours, were maintained by some corresponding tendency of the organism, reached each new stage of their development by repeated trials, treasured the past experiences of the individual and of the race, and were thus gradually mechanized by way of mnemonic accumulation. They have finally become fixed or crystallized in complicated morphological structures which, like other acquired morphological modifications, can be transmitted indefinitely to succeeding generations.

The purposive aspect of the instincts is so evident that it is almost needless

to point it out. Although the more complex instincts are most striking, even those that seem the simplest present so perfect a co-ordination of movements as to appear no less marvellous. Hering, for example, studied the apparently simple instinct of the chicken which picks up grains of corn as soon as it comes out of the egg, analyzed it, and showed its great complexity.

If we pass from the simple instincts to the more complex, the identity of their purposiveness with that of intelligent acts, properly so-called, strikes the most untrained mind; there is only this difference, that instincts are already instructed by experience, while acts guided by intelligence need to learn from new experience.

But—incredible as it may seem—even the purposiveness of instincts has been denied by the extreme mechanists. Here again they have had recourse to chemical agents or hormones; here again they grossly confuse agents which merely release tendencies

already contained in the organism, with factors producing and forming the instincts. This attempt of theirs has only served to make evident the blinding effect, so mischievous to the progress of science, that may be wrought by preconceived ideas when held with an Olympian imperturbability, which neither self-criticism nor opposing facts can ever shake.

VII

Finalism of the Affective Tendencies

If we observe the behaviour of the various organisms from the unicellular types to man, we see that a whole series of their acts, including all the more fundamental, may be interpreted as the manifestation of the organism's tendency to maintain unchanged its physiological state.

If we reserve the term 'affective' for that special category of organic tendencies which are manifested subjectively in man as 'needs', 'appetites', or 'desires', and objectively in man and the animals as non-mechanized movements; then a first group of affective tendencies, thus defined, may be summed up in the one fundamental tendency of organisms to 'physiological invariance'. Thus hunger, thirst, the desire of the animal for its

environmental optimum, the need for elimination of refuse or harmful matter, the sexual instinct itself, and the so-called instinct of self-preservation, are but so many particular manifestations of this very general tendency. The most varied and complicated movements of approach or withdrawal, attack or flight, taking or rejecting, have all, directly or indirectly, the one exclusive end of maintaining or restoring normal physiological invariance.

To this first group may be added a second, comprising all the needs, appetites, or desires that arise *through habit.* Under this category comes the desire that springs up for relations of symbiosis and of parasitism after they have persisted a certain time, for example, those of mother and child, from which maternal affection has its origin. The other family affections come under this category, as also the affections of friendship, and of social relations, together with all the needs acquired in life by habits based on

accustomed environmental relation, and all the diverse nostalgias.

A third and last group is that of the *derived and composite* affective tendencies, which arise out of the two preceding groups, either by affective transference or by composition.

We have proved in our work, *Biological Memory*, that all these affective tendencies are due exclusively to the mnemonic property of living substance, that is, to specific complex accumulations of preceding physiological activities which tend to revive.

From all these affective tendencies arises that tendency to *the expansion and intensification of one's individual life* which characterizes man—the only animal that has so great a wealth and variety of affective accumulations.

The tendency to the expansion of individual life is substantially different from the tendency to the expansion of life in general. The latter depends on the impulse of solar or thermic energy which urges the metabolic process to

draw into its vortex an ever larger quantity of brute matter, and manifests itself in the multiplication, by generation, of the number of individuals, that is to say, by the increase of population. This last tendency may be called *passive*, inasmuch as it is due to an external impulse; while the tendency to the expansion and intensification of one's individual life is essentially *active*, for it depends not on external impulses, but on internal impulses, consisting of all the mnemonico-affective accumulations which are present in man in such great wealth and variety.

We shall see in our ninth and last section the importance of this active tendency to the expansion and intensification of individual life in the social relations.

It would be useless to take up time in showing that nothing in the least like affective tendencies is ever manifested by brute matter, by antonomasia called *inert*. Certainly heavy bodies 'tend' toward the centre of the earth,

and a piece of cork, when sunk under the water, ' tends ' to get back to the surface. Certainly two chemical elements with strong mutual affinities ' tend ' to combine, and air ' tends ' to rush into a vacuum. But these inorganic phenomena of impulsion or attraction are due to forces *external* to the respective bodies, to which they yield passively; while in the affective tendencies, whether of animals or man, the forces are *internal*, autonomous, and independent of the exterior. Hence the *activity* and *spontaneity* in the behaviour of living beings, which is in absolute contrast to the *passivity* and *inertia* of inanimate matter.

For these affective manifestations—purposive if ever there were such—the mechanists have not been able to attempt even the smallest beginning of an explanation. They have confined themselves to *denying* them in the animals, reducing their whole behaviour to a complicated play of tropisms; as far as man is concerned,

they have *excluded* them as outside of their jurisdiction, together with all the other facts pertaining to the spirit, *thus renouncing a unitary view and explanation of all the phenomena of life.*

VIII

Finalism of Mental Activity

We are now in a field clear of adversaries, for it is abandoned completely by the mechanists, who declare it outside their physico-chemical jurisdiction and implicitly renounce a unitary conception of life. This is a field in which purposiveness is too evident for demonstration, since every thought, every activity of the imagination or the reason, every meditated and voluntary act always has an 'end'.

Rather is it incumbent on us, as evidence that our mnemonic theory permits of a unitary explanation of life, to show how all the phenomena of mind—even the most complicated and elevated manifestations of the spirit—may be deduced from the one property of mnemonic accumulation, which we take to belong peculiarly and exclusively to life.

For this purpose it will suffice to show that all the phenomena of mind are derived from the reciprocal play of two elementary psychical phenomena, the affective tendencies and the sensorial evocations. Since both affective tendencies and sensorial evocations are of mnemonic origin and nature, if from their reciprocal action all the activity of the mind can be derived, it is clear that this activity will in the last analysis be derived from the mnemonic property.

And this is what we have sought to show in our work on *The Psychology of Reasoning*.

Thus, for example, from the conflict between an affective tendency toward a future end and another directed to a present end the *will* arises. From the conflict between a primary affective tendency which longs for a given good and a secondary affective tendency which holds it momentarily in suspense for fear that the primary impulse, if too soon freed for action, might not reach the desired result, *attention*

springs up, with all its more accurate perception and examination of what arouses interest. The too sudden and too intense action of the affective tendencies gives rise to the *emotions;* and with the abatement of this suddenness and intensity all the gamut of the human *sentiments* arise. *Cool tenacity in action* is affective but not emotive, and is the more efficacious the less is the portion of the affective discharge dispersed in the disordered and useless visceral commotions which constitute the emotions.

Consciousness—the great enigma of psychic life— seems to us to be, not an intrinsic and absolute property of the psychic states themselves, but a property extrinsic and relative to each one of them, due to certain modalities of affective reference which these psychic states present in relation to one another. And *unity of consciousness* seems due to the great extension of the respective seats of the affective tendencies in the brain, which makes it

generally impossible for more than one affective ' constellation ' to be in action at one moment (excepting the normal cases of *absent-mindedness*, and the pathological ones of *double personality*).

Reasoning appears to us to be nothing but a concatenated series of experiences that are merely thought: and the reasoner who thinks ' with attention ' seems moved at the same time by a primary and a secondary affective tendency ; the primary, by means of suited sensorial evocations, imagines and follows ' with the mind's eye ' the various experimental combinations or vicissitudes to which the object of attention is mentally subjected; and the secondary holds the primary in suspense at each step, for fear of attributing to each imagined experience a result other than this experience would give if actually accomplished.

On the greater or less persistence of the primary depends the *coherence* or *incoherence* of the intellectual process, and on the greater or less persistence

of the secondary depends the *logicalness* or the *illogicalness* of the reasoning. This is confirmed first by the study of *dreams*, which are incoherent and illogical at the same time on account of their non-affectivity; and secondly by studying *the reasonings of the insane*, which in mono-maniacs are coherent but illogical, while in the insane characterized by the instability, impotence, or absence of the affective tendencies the reasonings are remarkable for their incoherence.

From the affective classification the *concepts* arise, and reasoning bases itself more and more on these in its double evolution *from concrete reasoning to abstract reasoning* and *from intuitive to deductive reasoning*, until the heights of *mathematical reasoning* are attained.

Objective and constructive reasoning, or real and properly so-called reasoning, is impelled only by the desire to know and discover the truth, that is, to foresee the consequences of acts before beginning them. From

this type of reasoning we have distinguished *intentional or classificatory reasoning* — *dialectic* and *metaphysical*— the purpose of which is to make given facts appear to belong to certain categories rather than to others, and to prove the whole universe to be what we wish rather than what it actually is.

Affective activity, therefore, seems to permeate all the manifestations of thought. Nay, it seems to us the only actual constructor of thought, which uses the material of imaginative records stored up in our sensorial mnemonic accumulations, and erects the whole imaginative and ratiocinative edifice of our spirit, from the humblest and lowest of the dull-minded, to the highest and most sublime proper to the man of genius.

In this way all the working of the intelligence, which is the most characteristic manifestation of the purposive aspect of life, has found in our mnemonic hypothesis its complete explanation,

while it proves irrefutably the absolute insufficiency of the mechanistic theory to explain the whole of life.

IX

Finalism of the Social Manifestations

Justice and Morality

It should not awake surprise that a essay on the purposiveness of life should deal with the purposiveness of social manifestations. Society, as the sum or result of manifold human individuals, must reflect, in one way or another, the purposiveness of these individuals; and, vice versa, the purposiveness of social manifestations will be a new proof, *ad abundantiam,* of the purposiveness of life.

The purposive social manifestations, where the purposes of the components converge, do not substantially differ from those of the components. But the case is different when the particular aims of individual members come into conflict with each other and with the collective aim; and this may happen

even though the collective aim is but the resultant of all the single ones.

In the course of its evolution society has produced two orders of social facts, diametrically opposed to each other.

On one hand, with the complication of society there has been a great increase in the motives of conflict between different individual aims and between individual and collective aims.

On the other hand, simultaneously with the increase of these motives of conflict, there has arisen a collective aspiration toward the assuagement and conciliation of these conflicts. This is due to the ever growing intensity and extent of the social relations, and to the more continuous and intimate communion of affective and spiritual life between the members of the collective body, so that in the finer spirits, in whom this communion is fullest, the aims of others have become their own. This aspiration has arisen little by little until it has become an im-

perious and irresistible urge to substitute for conflict the harmony of the whole of life.

Thus arise the two great problems of social purposiveness, exclusively proper to man, *justice and morality*.

Justice consists in seeking those social constitutions and institutions suited to guide the individual activities into proper channels so that their respective aims may come into collision as little as possible; that their conflicts, if inevitable, may at least be attenuated; that single aims may diverge as little as possible from the collective, or, better still, converge with it; so as, in short, to produce, by *external adjustment*, the greatest possible harmony between diverse individual aims and those of the collective body.

A formidable problem this, which has tormented society from its first rude manifestations in the taboo and the law of talion to the most perfect juridical elaborations of our civilizations; which, through the so-called

philosophy of law, involves the whole theory of the State and of its institutions, including the regulation of property, and all civil and penal legislation; and which comprises the study of the various social and political regimes, autocratic, oligarchic, and democratic. This problem also includes all the diverse relations between the individual and the State, from the one extreme of excessive individualism which leaves the collective finalism undefended in face of the chaotic and anarchic aims of the various members, to the other extreme of a suffocating idolatry of the State, which gives over the individual finalisms to the tyranny of the collective finalism, which finalism is never really general, but, as a rule, only that of restricted privileged castes, who dominate and exploit the others.

A formidable problem, which, in the practical sphere, under the incessant pressure of the finalisms or interests of the oppressed classes, has given rise

to an ever greater correction of injustices and iniquities; and which has led, in all the spheres of social relations, to the growing substitution of the regime of free contract, the pre-eminent harmonizer of single interests, for the regime of coercion which inevitably tramples on the interests of the many for the advantage of the few. In the theoretical sphere the problem of justice has given rise to all the idealistic attempts of humanity, from Plato's *Republic*, Campanella's *City of the Sun*, and Thomas More's *Utopia*, to the socialistic ideal which is the hope and faith of the present generation. To the realization of this ideal the author also sought to contribute, to the best of his then youthful forces, in the work *Un Socialisme en Harmonie avec la Doctrine Economique Libérale*, which he has since followed up and developed in subsequent secondary publications. (See, f.i. *The Social Significance of Death Duties*, 1925.)

The second problem, that of Morality

—to which in his future studies the author proposes to devote all his more mature but still fervid forces—seeks how best to mould the affective psyche of individuals so as to guarantee that the maximum number of their finalisms shall, *by purely internal adjustment,* be harmonized with each other and with those of society. In other words, it seeks that supreme ethic postulate, to be inculcated in the affective human psyche, from which may be deduced all those particular moral precepts which secure the spontaneous and harmonious adjustment of the vital activities of individuals in relation with one another.

In this way, instead of the activity and satisfaction of some individuals inhibiting and arresting that of others, the various affections and aspirations of all the members of society could give themselves full and free play—nay, could stimulate and intensify one another, with a maximum of activity and joy in life, with a minimum of

restraint and sorrow.

We may thus hope that *the harmony of life* will gradually take the place of the struggle for life. As we saw above, in the section relating to the affective tendencies, it is only the brute beasts who submit passively to that external impulse toward vital expansion which results in the multiplication of individuals, and which fatally gives rise to the struggle for existence whenever the population of all the species or of any single species exceeds that permitted by the environment. On the contrary, man, in his morally highest representatives, is already capable of curbing or guiding this exterior impulse at will, so as to confine human population within the limits of available subsistence—limits, moreover, which technical progress so continually extends as to leave always a large margin. And we saw how man substitutes for the passive acceptance of this exterior impulse a whole series of interior impulses based on the mnemonic-

affective accumulations which he has in such abundance and variety, and which together give rise to the tendency, here truly active, to the expansion and intensification of individual life.

To-day, therefore, it depends only on the quality of these affective accumulations, and above all on their numberless modes of combination, composition, transference, and transformation, whether this active tendency towards the expansion and intensification of individual life shall continue to give rise to a struggle of wolves against wolves, or resolve itself into a harmony of life where all the individual finalisms take their proper and peculiar places in the finalism of human society as a whole.

Affective education on the one hand, together with the collective sanction on the other, must strive to arouse in ever increasing numbers those affective transferences, combinations, compositions, and exaltations which hush discordant egoisms and transform them

into concordant ego-altruistic or altruistic affections. And it is the task of the moral genius, be he a Socrates or a Jesus of Nazareth, first to feel in himself, and afterwards to bring forth in others, new affective combinations such as the human soul has never before experienced; to discover and divulge new ethical postulates such as never were on men's lips before, which shall be so many successive mile-stones on the difficult road to the radiant human destiny of the universally joyous harmony of life.

Let not the incredulity of the sceptic, who points to the sadness of the present, stop us or dampen our enthusiasm in this vision of a better and higher humanity. The way has been much longer, from the first metabolic attempts toward the stability of primeval unformed protoplasm to the whole finalism of life with all its infinite variety and magnificence culminating in the most noble ideals of the morally superior man, than the path which human

society has yet to tread, in order to pass from its imperfect attempts to master and soften the harshness of selfishness and hatred to the complete triumph of its own particular finalism, which has been already attained by a minority of the elect, but which will only be completed in the brotherhood and love of all human beings.

And, as the smile of the radiant eyes of Beatrice drew up the body of the Poet through the heavens, so may this radiant vision of a future humanity, smiling in joyous love, draw us with faith and enthusiasm along the rough path that we yet must tread together to attain this higher level of humanity.

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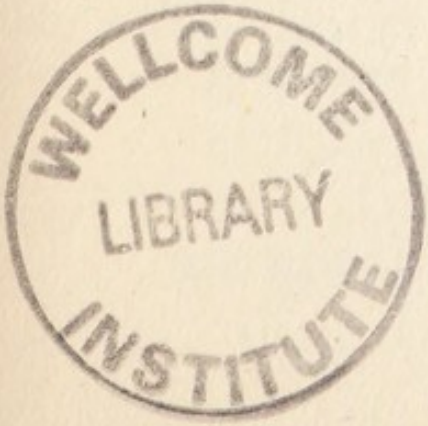

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