

# FROM BIOMOLECULES TO PSYCHOLOGY

## I. INTRODUCTION

In the last fifteen years, biology has made such considerable progress that it arouses the highest hopes. But despite the importance of the discoveries, particularly in the field of molecular genetics, one must admit that much still remains to be done if life is to be appreciated as a whole, including superior organisms. However, research is facing the complexity of the problem with ever-increasing success, moving in a completely new direction, not simply on a cellular level, but on a molecular and atomic scale. It is this radical change in thinking methods that might perhaps enable the scientist of today to study hitherto out-of-the-way fields, albeit still from a highly speculative point of view, by giving him scope for new ways of thinking. This is particularly true of psychology which, it seems, has not as yet been the subject of reasoning on a molecular scale.

Our only aim here is to suggest a method for dealing with the analysis of concepts, based on that of those astonishing mole-

Translated by M. S.

cules of nucleic acid which constitute the common denominator of all living earthly beings and which are the essential agents of information which condition the structure of enzymes and hence of all biomolecules. Our study must of necessity be couched in terms which are still very general and sometimes vague.

It is through adopting the idea, favoured by Crick and Orgel,<sup>1</sup> that the genetic code itself underwent a slow process of evolution, that one is enabled to adopt a point of view which leads to a clearer understanding of primitive realities such as the unconscious and the conscious (though one must draw on a very general mechanism, whose external context cannot be ignored).

First and foremost, modern views on the origins of life must be briefly summarised in order to grasp the basic essentials of the problem.

## II. ORIGINS OF LIFE

The most ancient fossils that have hitherto been discovered are about three thousand million years old. But the recently-developed concept of molecular fossils<sup>2</sup> allows in principle for the possibility of discovering traces of even more ancient life, because of the remarkable stability of certain biomolecules which can survive the destruction of their morphological organization. Thus the four or five thousand million years of age normally assigned to the crust of the earth may rapidly become too short a time for the indispensable period of chemical elaboration, known as the prebiotic phase, which preceded the evolution of living beings. This possible difficulty might not arise, for, according to some writers,<sup>3</sup> the solar nebula, from which the earth originated, had already included a phase of preparatory activity of this kind.

However this may be, the giant macromolecules of nucleic acids (whose molecular weight can be as high as  $10^{11}$ ) must

<sup>1</sup> F. H. C. Crick, *J. Mol. Biol.*, 38, 367, 1968; L. E. Orgel, *ibid.*, 38, 381, 1968.

<sup>2</sup> M. Calvin, *Chemical Evolution*, Oxford, Clarendon Press, 1969.

<sup>3</sup> M. H. Studier, R. Hayatsu and E. Anders, *Geochimica et Cosmochimica Acta*, 32, 151, 1968.

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have undergone considerable changes during the course of their evolution. This is not simply because the genetic code, now based on four well-known purine and pyrimidine bases, is simply a transitory state, and because, in the very distant past, life evolved on the basis of a much more restricted quantity of information.<sup>1</sup> One must also realize, and this is the essential point in our argument, that molecular events cannot be isolated and that they are in fact very closely linked with the cosmic environment.

These two interrelated facts, then, imply a principle of action and reaction which tends too often to be neglected due to the complications it involves, but which will form the subject of our argument.

### III. THE INDIVIDUAL

That lovely and moving spatial structure, the double helix, which x-ray diffraction studies have shown us,<sup>4</sup> is nothing other than an idealized form of the various realities which are indeed present in the living cell. Nucleic acid becomes really significant only when it acts and when its constitution and its very configuration can be very different. From this one can extrapolate at once that living beings cannot themselves claim any real individuality either: for they are linked to the whole external universe by universal forces (gravitational forces and those of electrical origin, such as Van der Waals forces). No one now knows the exact influence of these forces which, besides producing auditory, visual and olfactory effects, can play a particularly important part in crowd psychology. But it is plain that increasing interaction among the members of a group has a progressively weakening effect on their personality. In other words, the characteristic traits of a single individual tend to be modified as a function of their interactions, giving way to a structure which is that of society; here, as a kind of compensatory measure, there exists a new character which acts to the detriment of the individual parts of the whole. In this respect, to say that man

<sup>4</sup> J. D. Watson, *Molecular Biology of the Gene*, New York, W. A. Benjamin Inc., 1965.

is a social animal is to affirm that he has an intrinsic tendency to abandon his isolation to integrate himself (and partly lose himself) into a setting. Here, doubtless, we have the origins of idealist theories of collectivism, which, due to an obscure instinct, was opposed to liberalism (an illustration of the opposite need, since it involves the cult of the individual).

#### IV. THE UNCONSCIOUS AND THE CONSCIOUS

The evolution of the species, as conceived by those great thinkers, Lamarck and Darwin, can be completed by an initial molecular evolution,<sup>5</sup> as we have shown. Thus our vision of life nowadays is no longer separable from its history. Hence it is exhilaratingly coherent and global and provides us with a multitude of perspectives. Moreover, the fact of situating the origin of life in the nebulae, or at least in the primitive atmosphere of the planets, suggests that the process is not necessarily exclusive to the earth, and that, on the contrary, it may be a universal phenomenon. The solar system contains a whole series of sites in which the mechanisms generating life may well have acted at a given time. Carbonised meteorites are a striking illustration of this fact. For they are celestial bodies which probably emanated from this system, but which are completely independent of the earth, which undoubtedly contain organic molecules,<sup>6</sup> such as some of the bases of nucleic acids, and even pristane and phytane, which are substances akin to chlorophyll. One cannot as yet affirm that they are left over from a period of biological activity, however elementary. But even if they are abiogenic structures, we can at least infer that the molecules necessary for life can be formed outside the earth.

Thus one can conclude that the prebiotic process is a general phenomenon which must occur among the planets of the galactic world, provided that the luminosity of the star around which they revolve be sufficiently stable for periods of several thousand million years, and that the distance between the two systems

<sup>5</sup> J. Duchesne, "L'évolution chimique et l'origine de la vie," *Bull. Acad. Roy. Belg.*, 48, 1427, 1962.

<sup>6</sup> J. Duchesne, *Science Journal*, 5, 33, 1969.

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be adequate as to temperature. Thus our vision expands to view life as a forward progress on a cosmic scale (depending on the conditions of planetary evolution). Although it is highly improbable that it has developed beyond an extremely elementary stage in our solar system, it is nevertheless uplifting to think that somewhere in the heart of our galaxies there have probably evolved advanced species of being. Like stars and galaxies, the molecule of nucleic acid is impregnated, during the course of its genesis, by interacting with the external world (through collisions, radiation, electrical and magnetic influences), with the most fundamental cosmic laws. In other words, the way we represent it can be considered only as an idealisation, while reality, which is extremely different, comprises many divergences. It is by this process that DNA becomes familiar not only with space (three-dimensional structuring) but also with ageing (time), and mutations (rapid transformations, or even what we might call internal and reversible metamorphoses).

To appreciate the historical meaning of this process, is it not sufficient to consider the analogy of the classical crystallographers, who likewise thought of their crystal in its pure state as a faultless reproduction of an elementary structural element? Now modern research has taught us that it is precisely the defects in the crystalline structure (the possibly insignificant departures from the initial ideal form) that produce some of the most essential and most important properties of the substance. If one applies the same methodology to the molecule of DNA, which can be compared to crystals since it is so extraordinarily large—it contains about a thousand million atoms—one realizes that it is precisely the defects, which must not be confused with imperfections in the moral sense, somehow injected by the external surroundings into the ideal structure, that determine the real intrinsic characteristics of the individual thing that contains them. Similarly, this close association of the molecule with its surroundings explains the difference between individuals, both within a particular species and members of different classes of organisms: for the cosmic adventure is not unique. It must, however, be noted that every variation in surroundings does not *ipso facto* disrupt living matter. For this matter can to a certain extent preserve its autonomy, thanks to the phenomenon of

auto-regulation, which repairs the damage and restores it to its normal state.

Clearly, however, it is impossible for various defects to accumulate in a molecule indefinitely, any more than they could build up in a crystal without catastrophic results; it is precisely in this critical zone that lethality and cretinism are determined, as if we were involved with a phase change at a given critical temperature. Plainly, small molecules like the modest water molecule, made up of only three atoms, cannot take part in such a process. Indeed, let but a hydrogen atom be removed, by mischance, from such a system, and the properties of the resulting group will bear no resemblance to the initial object. But the expulsion of one single atom from a giant molecule, effected by the environment, and which might not alter the structure sufficiently for our amazingly efficient methods of observation to detect the change, might nevertheless bring about an essential change in the reproductive mechanism (that is to say, it might produce some change in hereditary properties). Thus the important defects are those that prevent reproduction from taking place faultlessly, as it would were the make-up of the helix that determines heredity to remain intact. But this infra-determination must have consequences that exceed the framework of variations between individuals. If all beings of a given class (and, in particular, men) were constructed from ideal components, the result would perhaps be rather dull, but scarcely tragic. But the need for defects shows that basically the individual is the mirror of Nature in its totality. In other words, the unconscious is nothing other than the sum of defects acquired progressively by genetic molecules during the course of their long and turbulent history. As for the conscious, it occupies essentially a more or less large proportion of that vast gamut of information within each individual, which he can bring to his notice. Thus the progressive development in conscious thought, during the course of evolution, is the result of a structural detail in the transmission of the code linked to the development of the central nervous system, a detail which reflects the interactions of the system with the external world. Seen in this new perspective, the conscious and the unconscious can be reduced to one fundamental reality, a molecular structure in the heart of its cosmic context!

As for the hypothesis of a life based, no longer on carbon,

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but on silicon, it can scarcely be supported today. For, precisely, the adaptability of molecules with conjugated bonds is much greater than that of silicon compounds, however subtle. Indeed, this class of molecules exhibits that property which is an essential for life: stability, which ensures that it will be maintained, combined with relative instability, which enables it to survive in the event of disturbance from outside. In other words, a sort of plasticity is the very condition of life. Moreover, and this provides further proof, meteorites have no adequate silicon compounds and consequently suggest a chemical evolution based on carbon.

### V. ORIGIN OF IDEAS

Evidently, each individual contains within him a source of ideas. This is no doubt why the deepest, nay the most instinctive concepts on which human thought has never ceased to model itself, seem to have welled up so spontaneously in Leucippus, Democritus, Parmenides, Heraclitus and others. These philosophers have laid the foundations of our ideas of space, of continuity and discontinuity, of time, of evolution. There seems little doubt that their so-called creative vision is as much the result of a powerful upsurge of their unconscious as of a logical process of deduction based on objective observation of things. Did not Einstein himself, according to Max Born, have faith in the power of reason to guess at the laws governing God's creation of the universe?<sup>7</sup> Long before him, other great thinkers, including Plato, with his theory of the objective reality of ideas, Spinoza and Leibniz, had sensed the existence of a similar mechanism.

Belief in the unity of natural phenomena, for its part, was nobly expressed by Lucretius, a contemporary of Julius Caesar's, who, in an admirable attempt at synthesis, affirmed that the earth, the moon, the stars and all living things were the product of a single mechanism linked to the movement of atoms, made up of a single type of matter and moving in space.

The difference between man and all other living things boils

<sup>7</sup> *Science et Synthèse* (Coll. Idées, N.R.F.), Paris, Gallimard, 1967.

down to his greater ability to bring to light the depths of his own unconscious. In other words, one can say that animals are better adapted to Nature, meaning that less of their unconscious is free and accessible to the understanding. It is plain that this viewpoint necessarily involves the idea that there is no qualitative difference in the very essence of their lives. However, the variability of the extent to which the unconscious becomes the conscious in the animal world makes man so different from animals, particularly when he is a genius, that it corresponds, practically speaking, to a qualitative difference between him and animals.

## VI. SOLIDARITY AND ANTAGONISM

The line which extends from the most distant past to the life of the individual of today clearly owes its continuity to an ability to adapt and to improve, which allowed for the overcoming of an infinite number of obstacles capable of putting an end to evolution, during the process of natural selection. Thus survival basically depends on an immense destruction of life and, deep down, living beings must of necessity have feelings of aggression. It follows that in the mechanism of evolution solidarity and antagonism are connected, in accordance with Heraclitus's view; according to him, the whole process of being would be in danger of destruction if the discord between men and gods were to disappear.

Let us imagine a group of individuals ruled exclusively by the forces of attraction or solidarity; this will help us to understand the deep need for antagonism. In such a situation, the individual consciousness would tend to disappear, and if this process were to be prolonged, the individual would progressively disappear, to be replaced by a super-consciousness! But any group movement always incorporates aggressivity which restores the initial order of things and ensures the maintenance of the unitary component. These forces of repulsion, essential for the formation of the living being in all his ontogenetic development, thus provide him with protection. From this point of view one can understand that admirable equilibrium between opposing



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forces by referring to a principle of symmetry as the ruling feature of animal and human psychology. And yet the organism is made up of thousands of millions of cells, which, for their part, have given up their personal character to form a collective order of a superior nature. On the other hand, they have a limited life-span. Cells have learnt solidarity because each one is highly specialized, so that they are considerably interdependent on each other. They have actually given up living in the strict sense of the word, although they can be separated from the individual and cultured under glass, given appropriate conditions.

### VII. SEXUALITY

Protozoa, unicellular organisms, multiply and hence survive and reproduce, without the interference of sexual phenomena.<sup>8</sup> As for sexual reproduction, it seems to be one of the aspects of evolution which permits of the regeneration of the genetic patrimony, that is to say the recreation of order in a state of progressive disorder. With mankind, where order, due to the superior development of the consciousness, is of considerable importance, the tendency towards eroticism produces a type of interaction which though it has few repercussions is opposed to that which characterizes a group. If we apply the principle of symmetry here too, we must acknowledge that the true end of this state is to deliver the individual from his conscious organization, which can seem burdensome at times, and to integrate him more fully into the cosmos. But this sort of short-lived disorder can go together with fecundation, which tends towards order.

Thus the eroticism-procreation duality should not be thought of as a simple relation of cause to effect where the only aim of the first term is to ensure the continuation of the race. It actually represents a double equilibrium, order-disorder-order, which ensures not only the survival of the species but also that of the individual himself. By endowing life with an escape from order, eroticism puts off the fatal moment of death!

<sup>8</sup> P. Brien, *Scientia*, 6th series, 1, 1964.

## VIII. SLEEP AND DREAMS

When he is asleep, man completely escapes from interaction with other individuals, and hence finds himself in an ideal situation for reconstituting his own personality, that is to say his personal order. This is one of the chief characteristics of this remarkable condition.

Just as procreation and eroticism are complementary, so sleep and dreams seem closely linked, and represent, respectively, order and the entry through disorder to a bigger world. And this sort of liberation from the exigencies of the consciousness allow of a deeper incursion into the realms of the unconscious, and hence sometimes result in a subtler understanding of the genetic code and consequently a more effective contact with the structure of the universe.

## IX. THE PHENOMENON OF RELIGION

The problem of the origins of deism seems to play an equally natural part in the new pattern. God, eternal and boundless at once, is the very quintessence of the Cosmos, and constitutes for man a wondrous centre of polarization, that is to say of universal order!

But on the other hand the complementary and inseparable side of the question, that is to say Satanism, is nothing other than the exigency of consciousness restricted and limited within the framework of time. Divine contemplation answers the individual's need for universal synthesis, but Satan keeps him confined within a narrow, analytic framework. Thus religious sentiment represents one of the great positive aspects of life in its confrontation with the opposite tendency. Thus the statement that deism is solely the product of the anxiety of man, lost in a universe he does not understand, in which reigns chance alone, is meaningless. No system, then, can hope to annul a tendency which is linked to the very structure of the human being.

## X. CONCLUSIONS

The model system suggested here has the advantage of providing the basis for a synthesis of certain fundamental characteristics

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of psychology. It integrates the important, apparently contradictory aspects of animal and human activity into a general principle of symmetry, with which is naturally associated a sort of law of preservation of such a kind that the sum of the contrary elements is a constant. Basically, the physical world works in a similar way, and one must clearly not wonder at the similarity between the methodology which inspires them. For instance, it is known that one cannot produce a positive electric charge without simultaneously producing an equivalent negative charge, and this fact is related to a law of preservation of the total charge in the universe.

Further, it is at present impossible to enumerate the types of defect which, by affecting the ideal structures of DNA molecules, govern the individual's unconscious. But the requirements of the infinite variety of types imposes their vast size on the genetic molecules, since they must be able to undergo, without disaster, a multitude of transformations. The hypothesis of the essential part played by structural defects is, it appears, simple and suggestive. As techniques of observation become more refined, we should, in future years, be able progressively to verify the validity of this theory. Thus the unconscious will be accessible to other techniques than those of psychoanalysis!

These observations, which confer the same nature to solidarity and antagonism, to the divine and the diabolical, express the grandeur and at the same time the tragedy of the human condition. But the impression of beauty that this simplicity gives is exalting. For establishing a correlation on a cosmic plane between molecules and consciousness does not reduce man to the level of a machine: so that it helps to clarify an eternal controversy. Indeed, to dissociate molecules, life and the spirit from each other is a supreme artifice. Life is an historic, global phenomenon whose cosmic transcendence is manifest. If one penetrates it, one cannot see it as a whole. We are still very far from understanding this perspective, but with our modern methods of analysis on a molecular and atomic scale, we are no doubt in a position to anticipate it and, above all, to expect that we will be able to deal with it better!

Morals themselves can now be viewed in a different light. For man, that is every man alive today, is not as old as his years; he is some five thousand million years old. Children, old

without being old, are prodigies whose genes contain a universe in miniature, and consequently represent divine grandeur. This view places conscious life in the forefront of nature; man is no longer a poor creature in the universe, since, in a sense, he is a microcosm himself. That is why respect for life should be our law. But how can one ensure it, what equilibrium can one find in these contradictory tendencies within us, what is to be the destiny of humanity? We must in the future study these problems in the context of the framework we have tried to define. Are we in danger of vegetating until the sun has become cold and the frozen earth is incompatible with life? Or will we one day transpose our unconscious more completely into our conscious and become like gods? In which case, will we not be so completely structured that we will tend towards total disintegration?

The theory that the human consciousness is the very essence of the cosmos, which Norrish has also suggested,<sup>9</sup> leads to an integral form of monism, which, to some extent, is reminiscent of the moving doctrines of the Eleatic school in Greece, 2500 years ago.

As Eugène Wigner writes,<sup>10</sup> philosophers, who have a larger vocabulary than physicists, have greater faith in words than the latter. No doubt this means that the former have established a conscious belief that language was created to express concepts which lie in instinct. The physicists, on the other hand, tend to base their theories on more primitive concepts, precisely those we have alluded to here. However this may be, trusting words, which are nothing other than the expression of information contained within man, basically implies that concepts emanate directly from the unconscious.

Let us now ask whether modern views to some extent at least resolve the old quarrel between the upholders of free will and those of absolute determinism. It seems to me that the answer is yes. Free will is the expression of the retroactive impact of the relationship between the conscious and the unconscious on a given individual, where the sum of these two terms is approximately constant. Clearly, this free will can vary within a single class, and must decrease towards zero when one moves from

<sup>9</sup> R. G. Norrish, *Journ. Roy. Inst. of Chem.*, p. 151, 1959.

<sup>10</sup> E. Wigner, *Proc. Amer. Phil. Soc.*, 113, 95, 1969.

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man to more primitive species. Thus the duality determinism-free will can be combined without a contradiction being involved.

In conclusion, it may be interesting to consider whether one can know where life is placed in this infinite chain of events which lead from biomolecules to psychology. As we have seen, nothing in the emergence of the living being can be separated from its context. Is it possible to pick out a critical limit beyond which life is manifested? In order to answer this question, let us consider very briefly the phenomena of reviviscence, with the accent on the importance of organization. During the course of the fine program research followed by Paul Becquerel<sup>11</sup> in France, and, more recently, in the works of Hinton<sup>12</sup> in Great Britain, seeds, lichens, tartigrades and even insects have been maintained in a state of latent life by being thoroughly dehydrated and maintained in a vacuum at temperatures close to absolute zero. Thus a complete suspension of metabolism and the presence of apparently appreciable modifications in the cellular structures do not prevent revival. This means that organization is the fundamental factor necessary to life. But one must next ask at what stage life begins to disappear. Experiments based on cellular magnetism carried out in my laboratory on lichens dried from as long 200 years ago to as recently as nowadays, have not yet provided an answer to this basic question which continues to be studied. This way of looking at things has the apparent advantage of indicating that the borderline structure is the one that permits the metabolism to reestablish itself, and probably to establish itself, if one may be allowed the belief that on the borders of life, survival and life are indistinguishable!

It is, I hope, clearer that the cosmic and the organic are essentially inseparable, on both a sub-microscopic, a microscopic and a macroscopic scale; and also that the universe is to some extent biocentric, with its tendency towards structure.<sup>13</sup>

It remains for me to express my sincere gratitude to all those who helped me with valuable encouragement and criticism. In

<sup>11</sup> Paul Becquerel, *Comptes rendus*, Paris, 231, 261, 1950.

<sup>12</sup> H. E. Hinton, *Proc. Roy. Soc. B.*, 171, 43, 1968.

<sup>13</sup> E. Kahane, *La vie n'existe pas!*, Paris, Les éditions de l'Union Rationaliste, 1962; I. Prigogine, "Structure, Dissipation, and Life," in *Theoretical Physics and Biology*, Ed. M. Marois, Amsterdam, North Holland Publishing Co., 1969.

particular, I should like to mention Professors C. A. Coulson and M. H. Pirene of Oxford University, E. Kahane of the University of Montpellier, A. Szent-Györgyi of Woods Hole (Mass., U.S.A.), E. Wigner, Princeton University and Cl. Nicolau, Bucharest University, Reverend Father E. Bernimont, Dominican, Liège, and also my Belgian colleagues Messrs. L. van Bogaert, F. Bremer, P. Brien, A. Clemens, J. F. Cox, F. Duyckaerts, M. Florkin, R. Goutier, A. Meessen, F. Picard, B. Rosen and J. Serpe.