ENGELS AND SCIENCE

By J. D. BERNAL

If Engels had not been the constant companion in arms of Marx in the revolutionary struggles of the 19th century, there is no doubt that he would be remembered chiefly as one of the foremost scientist-philosophers of the century. It was an ironical tribute paid to the correctness of his views as to the relations between politics and ideology that he suffered complete neglect from the scientists of the Victorian age. But time now has taken its revenge, and Engels' contemporary views on 19th century science seem to us now in the 20th far more fresh and filled with understanding than those of the professional philosophers of science of his day, who for the most part are completely forgotten, while the few that linger on, such as Lange and Herbert Spencer, are only quoted as examples of the limitations of their times. It would, of course, be wrong to consider Engels' scientific achievement apart from his association with Marx. It was through Marx's influence, and by the methods of dialectical materialism they evolved together from Hegel's dialectic idealism, that he achieved the possibility of criticising and interpreting science in a manner which was not open to his predecessors.

Engels as a Scientist

It is often said by those anti-Marxists who never trouble to read the original writings that the scientific knowledge of Marx and Engels was superficial; that Engels, for instance, sought in later life for scientific justification for the dialectical laws that Marx had introduced into economics. This is a complete misreading of the facts. Engels' interest in and knowledge of science was deep and early. It ran through all his philosophical and political studies. In an essay as early as 1843 (quoted in the Marx-Engels, Selected Correspondence, p. 33), he shows a grasp of the fundamental connection between science and productivity that was to run through all his later work: –

> ....yet there still remains a third factor – which never counts for anything with the economists, it is true – namely science, and the advance of science is as limitless and at least as rapid as that of population. How much of the pro-

> gress of agriculture in this century is due to chemistry alone, and indeed to two men alone – Sir Humphry Davy and Justus Liebig? But science multiplies itself at least as much as population: population increases in relation to the number of the last generation; science advances in relation to the total amount of knowledge bequeathed to it by the last generation, and therefore under the most ordinary conditions in geometrical progression too – and what is impossible for science ?

Engels to the very end of his life not only made use of the science he had learnt at the University, but kept up with extraordinary keenness and understanding his interest in the scientific discoveries of his times. Far from being prejudiced by any preconceived theories, he was more open to accepting new ideas than were the professional scientists. In a letter to Marx in 1858, he shows himself prepared to accept beforehand the idea of transformation of species which Darwin was to publish in the next year (Marx-Engels, Correspondence, p. 114). In one passage he almost hints at the idea of evolution, derived from the Hegelian idea of transformation of quantity into quality: –

> So much is certain; comparative physiology gives one a withering contempt for the idealistic exaltation of man over the other animals. At every step one bumps up against the most complete uniformity of structure with the rest of the mammals, and in its main features this uniformity extends to all vertebrates and even – less clearly – to insects, crustaceans, earthworms, etc. The Hegelian business of the qualitative leap in the quantitative series is also very fine here.

A few months later, when Darwin's "Origin of Species" appeared, Engels and Marx together acclaim it as putting an end to teleology in the natural sciences. Already Engels on December 12, 1859, exactly four weeks after the publication of the first edition, writes to Marx: "Darwin, whom I am just now reading, is splendid," and Marx writes in reply: "Although it is developed in the crude English style, this is the book which contains the basis in natural history for our point of view."[1]

If we contrast this attitude to that of the official philosopher of science and physicist, Whewell, a great derider of Hegel, who was at the same time urging that Darwin's book be not accepted by Trinity College Library, we can measure the greater breadth and penetration which their philosophical outlook had given to Marx and Engels. It was the same with all the significant ideas which science was developing. The great physical and chemical advances of the century, particularly the conservation of energy and the development of organic chemistry, were also recognised and carefully studied by Marx and Engels. In his approach to science, Engels cannot be said to have been an amateur. In Manchester, where he spent most of his life, there was a very lively scientific life with which he freely mixed, and, in particular, he had as his intimate friend Karl Schorlemmer, the first Communist Fellow of the Royal Society, and one of the most distinguished chemists of his time.

The width of Engels' scientific knowledge can be fully appreciated only from a study of his great unfinished work, *Dialectic and Nature.* In it different sciences are treated comprehensively and critically. It is easy to see from the authorities cited how close Engels was to contemporary developments in mathematical, physical, and biological sciences, to say nothing of sociology and economics. He even includes a short and amusing chapter on psychic science.

Engels on the History of Science

From the start Engels was able to unify his conceptions of science in such a way that he could naturally assimilate new developments as they appeared, and that without any of the wilder flights of such scientific philosophers as Haeckel or Herbert Spencer, but in an extremely sane and balanced way. The secret of this power lies in the materialist dialectic which he used in his analysis of the results of science. It was from Hegel that he learnt to appreciate, not things, but processes, and he always looked at the position which science had reached at any time in relation to its historical background. This is clearly seen in his essay on Feuerbach, where he traces the history of materialist philosophy in relation to the devel-

---

[1]Quoted by V. L. Komarov in *Marxism and Modern Thought,* p. 193. See also Marx-Engels, Correspondence, Letter 49.

opment of science and productive methods. For instance, he says: –

> But during this long period from Descartes to Hegel and from Hobbes to Feuerbach, the philosophers were by no means impelled, as they thought they were, solely by the force of pure reason. On the contrary. What really pushed them forward was the powerful and ever more rapidly onrushing progress of natural science and industry. Among the materialists this was plain on the surface, but the idealist systems also filled themselves more and more with a materialist content and attempted pantheistically to reconcile the antithesis between mind and matter. Thus, ultimately, the Hegelian system represents merely a materialism idealistically turned upside down in method and content....
>
> The materialism of this last century was predominantly mechanical, because at that time, of all natural sciences, mechanics and indeed only the mechanics of solid bodies – celestial and terrestrial – in short, the mechanics of gravity, had come to any definite close. Chemistry at that time existed only in its infantile, phlogistic form. Biology still lay in swaddling clothes; vegetable and animal organisms had been only roughly examined and were explained as the result of purely mechanical causes. As the animal was to Descartes, so was man a machine to the materialists of the eighteenth century. This exclusive application of the standards of mechanics to processes of a chemical and organic nature – in which processes, it is true, the laws of mechanics are also valid, but are pushed into the background by other and higher laws – constitutes a specific but at that time inevitable limitation of classical French materialism.
>
> The second specific limitation of this materialism lay in its inability to comprehend the universe as a process – as matter developing in an historical process. This was in accordance with the level of the natural science of that time, and with the metaphysical, *i.e.,* anti-dialectical manner of philosophising connected with it. Nature, it was known, was in constant motion. But according to the ideas of that time, this motion turned eternally in a circle and therefore never moved from the spot; it produced the same results

over and over again. (*Feuerbach*, pp. 36 and 37.)

As a historian of science Engels is particularly distinguished. He was the first to understand with Marx the close relation between the development of scientific theory and of productive methods. Much of what now passes for new in the interpretation of historical science is to be found in the pages of *Dialectic and Nature*,[2] He notices, for instances, that the theory of heat did not develop from pure thought, but from a study of the economic working of steam engines, and comes to the conclusion: "Until now they have only boasted of what production owes to science, but science itself owes infinitely more to production."[3] In particular he shows how the metaphysical and statical attitude of the 18th century materialists based on Newton was broken down in favour of a view which reflects, though unconsciously, a dialectical progress: "The beginnings of revolutionary science faced a through and through conservative nature, in which everything is to-day as at the beginning of the world, and will be to the end of the world the same as it was at the beginning."[4] The breaches made in this outlook he indicates as, first Kant and Laplace's nebular hypothesis, second the development of geology and paleontology, third chemistry, which can synthesise organised substances and whose rules hold just as much for the processes of life, fourth the discovery of the conservation of energy, fifth Darwin's evolutionary theory, and sixth the synthesis of all the processes affecting life, animal ecology and distribution. The significance of the break is described as follows: –

> It was not the scientists but the philosophers who made the first breach in this fossilised outlook. In 1755 appeared Kant's "General Natural History and Theory of the Heavens." The problem of the first impulse was here set aside. The earth and the whole solar system appeared as something *become* in the course of time. If, before the appearance of this thought, the overwhelming majority of scien-

---

[2]Marx and Engels Archives (German edition) Vol. 2, pp. 173, 194, et seq.

[3]M.E.A., Vol. 2, p. 195.

[4]M.E.A., Vol. 2, p. 175.

> tists had not felt the fear expressed by Newton in his warning "Physics, Beware of Metaphysics!"[5] – then they would have drawn from this single discovery of genius by Kant such consequences as would have saved them infinite errors along circuitous paths, and an immense quantity of time and labour expended in a false direction. In Kant's discovery lay the germ of all further progress. If the earth was something which had become, then all its present geological, climatic and geographical condition had become also, its flora and fauna as well, and it must have a history not merely in space, but in time also. (Quoted by V. L. Komarov in *Marxism and Modern Thought,* p. 205. See also M.E.A., Vol. 2, p. 244.)

As a result of these movements of thought, Engels says: –

> The old teleology has gone to the devil, but now we have the knowledge that matter in its perpetual circulation moves according to laws that at certain stages – now here, now there – necessarily produce the thinking mind in organic existence. (M.E.A., Vol. 2, p. 175.)

Engels' concept of nature was always as a whole and as a process. He escaped the specialisation which even in those days made it impossible for a physicist to understand biology or vice-versa, and he laid down a general outline of this process which can still be the basis for an appreciation of the results of scientific research.

He never had the opportunity to put down in one place his view

---

[5]The use of the word metaphysical in Marxist literature is apt to cause confusion at first reading. The accepted popular use of the word is to connote assumptions which cannot be verified by concrete experience, generally, also somewhat vague and mystical assumptions. This is the sense in which it is used here and also the sense in which Marxism itself is said to be – quite wrongly – metaphysical. The Marxist use of the word, however, is more specialised. As can be seen from the quotations in this pamphlet, it is used only for a class of assumptions and categories that are abstract, fixed, eternal and capable of absolute contradiction, such as the categories of Aristotelian logic or pre-relativistic physics. In contrast to these are the fluid dialectical categories.

of this universal process. The main outlines can be seen in *Anti-Dühring,* or even better in the shortened form of *Socialism*, *Utopian and Scientific.* But for its full appreciation in this country we shall have to wait until the publication in English of *Dialectic and Nature.* Throughout Engels wages war on metaphysical ways of thinking in science, with its fixed categories and its sharp distinctions between cause and effect, structure and behaviour, identity and difference, whole and part.[6] These are not so much invalid as valid only in small, defined regions. The success of the scientific method is best seen in such regions: "For everyday use, for scientific retail trade, the metaphysical categories still keep their value."[7] The dialectical approach to science has its value, on the contrary, in its comprehensiveness. The movements first seen by Hegel in the ideal world are, according to Marx and Engels, simply reflections of those in the objective world. Much of Engels' studies were devoted to exemplifying the Hegelian modes, particularly those of the transformation of quantity into quality, the interpenetration of opposites and the negation of negation, in the world of science. In *Anti-Dühring* this is done in the shortest way. But the *Dialectic and Nature* contains far more examples.

The Transformation of Quantity into Quality

Philosophers still cavil at the use of the phrase "transformation of quantity into quality" on the grounds that it is not quantity that changes into quality, because quantity remains in the end. But the phrase is simply a shorthand way of referring to Hegel's law that purely quantitative changes turn into qualitative changes. It was in this form that Marx understood it, as shown explicitly in his letter to Engels (Letter 97). The examples which Engels gives, the case of ice turning into water, or water into steam, and that of the change of physical quality of a chemical substance with the number of atoms that are comprised in it, should have shown sufficiently clearly what this concept meant. With remarkable insight Engels says: –

> The so-called constants of physics are for the most part nothing but designations of the nodal points where quanti-

[6] M.E.A., Vol. 2, pp. 150 et seq.

[7] M.E.A., Vol. 2, p. 189.

> tative addition or withdrawal of motion calls forth a qualitative change in the state of the body in question. (M.E.A., Vol. 2, p. 288.)

We are only now beginning to appreciate the essential justice of these remarks and the significance of such nodal points. The whole theory of quanta depends, like the theory of acoustic vibrations with which it has formal relations, on the distribution of nodes which mark out two qualitatively and quantitatively different states of vibration.

The problem of qualities had always raised the greatest difficulties to the philosophers and furnished, as it still furnishes, a reason for invoking outside forces. From any logical materialist standpoint it is necessary to recognise that a new quality of a system is something not in any sense added to the system, but produced simply by a continuous change in its already existing components. To make this meaning perfectly clear, Engels cites as his final authority Napoleon.

> In conclusion we shall call one more witness for the transformation of quantity into quality, namely – Napoleon. He makes the following reference to the fights between the French cavalry, who were bad riders but disciplined, and the Mamelukes, who were undoubtedly the best horsemen of their time for single combat, but lacked discipline: "Two Mamelukes were undoubtedly more than a match for three Frenchmen; 300 Frenchmen could generally beat 300 Mamelukes, and 1,000 Frenchmen invariably defeated 1,500 Mamelukes." (*Anti-Dühring*, p. 146.)

Engels found many examples in science of this transformation. Of these I can only quote one, that of Mendeleyeff's Periodic Law, which was to prove in the future so rich in further examples of the transformation of quantity into quality.

> Finally, Hegel's law holds not only for compound bodies, but for the chemical elements themselves. We know now that chemical properties of elements are a periodic function of their atomic weight and consequently their quality is determined by the quantity of their atomic weight (or, as we would now say, of their atomic number), and the proof of this has been made in a most striking way.... By

> the help of the – unknown – application of Hegel's law of the change of quantity into quality, Mendeleyeff has achieved a scientific feat which can well stand comparison with Leverrier's calculation of the orbit of the still unknown planet Neptune.... Perhaps those gentlemen who up till now have treated the transformation of quantity into quality as mysticism and incomprehensible transcendentalism will now explain that it is all perfectly self-evident, trivial, and platitudinous, that it has been long familiar to them and that we have nothing new to teach them. To have put forward for the first time a general law of nature and thought, in its most generally valid form, that will always remain as a historical achievement of the first order, and if these gentlemen for so many years have allowed quantity and quality to turn into each other without knowing what they were doing, they must console themselves with Moliere's Monsieur Jourdain, who had all his life spoken prose unwittingly. (Engels' *Dialectic and Nature,* p. 289.)

Understood in this way, the concept of the transformation of quantity into quality can be, and is being, extremely valuable in scientific thought. We are learning more and more that specific qualitative properties of bodies depend on the *number* of certain of their internal components. If an atom can only link with *one* other atom, the result is a gas. If it can link with *two* or *three,* the result will be a solid of fibrous or platy character. If with *four,* a hard crystalline solid like diamond. If with *more than four,* a metal. Similarly the processes of freezing, boiling, vitrification, etc., depend on what are now known as "co-operative" phenomena. It takes a million or more molecules to make a substance which can be recognised as a solid or liquid: a smaller number leads to the qualitatively different colloid state.

The Interpenetration of Opposites

The concept of the interpenetration of opposites has not been given by Engels the same coherent treatment as that of the others. Yet it recurs nearly all the way through his scientific writings. It appears in two shapes, firstly, as the Hegelian idea that nothing can be defined apart from its opposite, that, so to speak, everything implies its opposite (here Engels approached very close to the modern ideas of relativity) but also more objectively that there exist no hard and fast lines in nature.

> "Hard and fast lines" are incompatible with the theory of development. Even the border line between vertebrates and invertebrates is no longer unchanging. Every day the lines of demarcation between fish and amphibia, between birds and reptiles, tend more and more to vanish. Between the *Compsognatus* (a small dinosaur) and the *Archaeopteryx* (a toothed bird of the same origin) only a few intermediary members are wanting, while toothed birds' beaks have been found in both hemispheres. (Quoted by V. L. Komarov in *Marxism and Modern Thought,* p. 199. See also M.E.A., Vol. 2, p. 189).

In physics Engels exemplified this principle by the example of magnetism, in which each N. Pole implies a S. Pole or vice-versa, or more generally in the balance between attraction and repulsion. Here, Engels' treatment is surprisingly modern. He understands forces not as mystical entities, but to be known only by the movements produced by them. This is characteristic of the modern tendency of turning mechanics into kinematics. In Engels' analysis attraction is simply the reflection of the coming together of bodies, as repulsion is of their separation. Thus heat in the kinetic theory of gases acts as a repulsive force.

The Negation of the Negation

It is the same with the principle of the negation of the negation, which Engels illustrates with the famous examples of the barley seed negating itself into a plant and the plant further negating itself into many seeds, as well as the mathematical examples of the product of negative quantities and the differential calculus. These are the kind of statements that until recently made dialectical materialism seem quite unacceptable, indeed incomprehensible to scientists trained along official lines. Negation has always seemed to them something only applicable to human statements, but this is just a defect of language. If we had a word to describe how something in the course of its own inner development can produce something else different and in some sense opposite to it, and which comes in time to replace it entirely, that word would take the place of negation. Negation in this sense is not a symmetrical operation; the negation of negation does not reproduce the original, but something now unlike both. As long as we deal in mere words, however, such statements can convey very little. It is in concrete examples that the significance of the negation of the negation can effectively be grasped. And if Hegel's and Engels' works had been treated on their merits instead of as something to be attacked in every possible way, the sense of their use of "negation of negation" would have been clearly apparent. But this, of course, would also have meant the recognition of the necessity of revolution, and that was far too uncomfortable to be accepted.

Just as the transformation of quantity to quality, so the principle of the negation of negation finds many examples in modern science. In almost every physical process in nature, there is a tendency for the process itself to create an opposition which ultimately brings it to a stop, which in turn results in the disappearance of the antagonistic process and the re-establishment of the original one. Take, for example, the case of the building up of mountain ranges due to strain in the earth's crust. This results in increased weathering which destroys the mountain range and accumulates sediments which lead to further crust strains, leading to further mountain building, etc. Modern physics is full of dialectical contradictions of this type – wave and particle, matter and energy – and even in Freudian psychology the provisional analyses of the mechanism of instinct and its repression are stated in a dialectical form. The whole of modern science is unconsciously affording more and more examples of the aspect of phenomena that can only be consciously grasped through dialectical materialism.

The Dialectical Process of Nature as a Whole

But Engels did not confine himself to scientific illustrations of the validity of his philosophical position. His main task was a constructive one, and he gives in several places both in his Letters, in the *Anti-Diihring,* and the essay on Feuerbach, his general view of the dialectical process of nature taken as a whole. (See particularly Letter 232 and Chapters 5 to 8 of *Anti-Dühring.*) *Dialectic and Nature* was intended to give such a complete conception, but it was never finished and contains as it stands a number of more or less filled-in sketches of such conceptions.[8] In the omitted fragment from Feuerbach (p. 76 of the English edition) he recapitulates the chief points in which the science of his time had served to lay the basis of a comprehensible materialistic view of the development of the universe. In this he lays stress on three discoveries of decisive importance:

> The first was the proof of the transformation of energy obtained from the discovery of the mechanical equivalent of heat (by Robert Mayer, Joule and Colding). All the innumerable operative causes in nature, which until then had led a mysterious inexplicable existence as so-called "forces" – mechanical force, heat, radiation (light and radiant heat), electricity, magnetism, the force of chemical combination and dissociation – are now proved to be special forms, modes of existence of one and the same energy, *i.e.,* motion.... The unity of all motion in nature is no longer a philosophical assertion but a fact of natural science.
>
> The second – chronologically earlier – discovery was that of the organic cell by Schwann and Schleiden – of the cell as the unit, out of the multiplication and differentiation of which all organisms, except the very lowest, arise and develop. With this discovery, the investigation of the organic, living products of nature – comparative anatomy and physiology, as well as embryology – was for the first time put upon a firm foundation. The mystery was removed from the origin, growth and structure of organisms. The hitherto incomprehensible miracle resolved itself into a process taking place according to a law essentially identical for all multi-cellular organisms.
>
> But an essential gap still remained. If all multi-cellular organisms – plants as well as animals, including man – grow from a single cell according to the law of cell-division, whence, then, comes the infinite variety of these organisms? This question was answered by the third great discovery, the theory of evolution, which was first presented in connected form and substantiated by Darwin….
>
> With these three great discoveries, the main processes

---

[8] M.E.A., Vol. 2, pp. 134, 153, 216.

> of nature are explained and traced back to natural causes. Only one thing remains to be done here: to explain the origin of life from inorganic nature. At the present stage of science, that means nothing else than the preparation of albuminous bodies from inorganic materials. Chemistry is approaching ever closer to this task. It is still a long way from it. But when we reflect that it was only in 1828 that the first organic body, urea, was prepared by Wohler from inorganic materials and that innumerable so-called compounds are now artificially prepared without any organic substances, we shall not be inclined to bid chemistry halt before the production of albumen. Up to now, chemistry has been able to prepare any organic substance, the composition of which is accurately known. As soon as the composition of albuminous bodies shall have become known, it will be possible to proceed to the production of live albumen. But that chemistry should achieve overnight what nature herself even under very favourable circumstances could succeed in doing on a few planets after millions of years – would be to demand a miracle.
>
> The materialist conception of nature, therefore, stands to-day on very different and firmer foundations than in the last century.

This quotation shows amply that not only had Engels a complete grasp of the essential stages of development up to the human level, but that he also saw very clearly the gaps in the explanation. The gaps are, first of all, the origin of the stellar universe as we know it, including the solar system and the earth, the origin of life on the earth, the origin of the human race, and the origin of civilisation. Each one of these questions was treated by Engels, and to each one he had valuable contributions to make.

The Origin of the Universe

Once dialectical materialism is understood, the logical absurdity of all creationist theories of the universe become apparent. It is not that dialectical materialism provides an alternate theory, but it shows that you cannot treat the Universe in the same way that you treat any part of it, as something acted on from outside. Whatever moves the Universe must be the Universe. In so far as it develops it is self-creating. In particular, it shows the childishness of assuming a personal Creator whether with the honest anthropomorphism of early tribal peoples or the reactionary idealism of the mathematician Godmakers of the present day. As Engels wrote: " Gott=Nescio, 'aber ignorantia non est argumentum' (Spinoza)."[9] At the same time he saw very clearly that there were social and political reasons for maintaining such beliefs, and of emphasising the helplessness of man before the existing state of nature and, by implication, the existing social and political order.

As to the origin of the universe, Engels put forward no new theory, but implied that the key to its discovery would lie in the study of the nature of matter and movement. Engels was from the beginning attracted to the nebular hypothesis, and enthusiastically took up the observations of spiral nebulae of which our galaxy is only one example.

The Origin of Life

As the last quotation shows, Engels believed, at a time when that belief was far less plausible than it is now, in the chemical origin of life as a definite period in the earth's development. Short of a special creation of life, which had already become scientifically suspect by the middle of the 19th century, the only alternative theory was that life had always existed. This theory, upheld with the authority of Liebig and Helmholz,[10] Engels energetically combated. "Why should not," asked Liebig, "organised life be as old, as eternal, as matter itself? Why should it not be as easy to imagine this as the eternity of carbon, and its compounds?" To this Engels answered:

> (*a*) Is carbon simple? If it is not, it is as such not eternal. (*b*) Carbon compounds are eternal only in the sense that under such and such conditions of mixture, temperature, pressure, etc., they can be reproduced. However, only the simplest carbon compounds, for example CO^2 and CH^4, can be eternal because they can be at all times and more or

---

[9] M.E.A., Vol. *2,* p. 169. "God = I don't know, but ignorance is no argument."

[10] M.E.A., Vol. 2, pp. 176 et seq.

> less in all places, produced and decomposed into their elements. (M.E.A., Vol. 2, p. 180.)

He argues that with these exceptions the conditions for the production of carbon compounds will not exist except on the earth in living beings or in the laboratory, and that though their eternal existence is thinkable, this merely shows that anything that is thought need not necessarily exist. Far stronger is the argument against the eternity of albumen, which can exist only under the very narrow limits of temperature and moisture of the earth.

> The atmospheres of astronomical bodies, particularly of nebulae, were originally white hot – no place for albumen – so that space must be the big reservoir, a reservoir lacking air and nourishment and at a temperature which no albuminous body can possibly exist…. What Helmholz says of the unsuccessfulness of experiment in making life is just childishness. Life is the mode of existence of albuminous substances: its intrinsic impetus comes from the continuous exchange of matter with the medium surrounding it, and with the ceasing of this exchange life itself ceases, and the albumen breaks up. (M.E.A., Vol. 2, p. 181.)

Time has not diminished the soundness of Engels' conclusions. We are still far from having analysed, much less synthesised, albuminous substances (for by that Engels did not mean protein in its modern sense as a pure crystalline chemical substance, but the complex of chemicals that underlie protoplasm – proteins, sugars, salts, etc. Nevertheless, through combination of modern biochemical knowledge with astrophysical and geological considerations about the early atmosphere of the planet, we can make a plausible picture of the origin of life by purely chemical means, and no other hypothesis for its origin can be put forward which will stand the slightest rational examination.

The Origin of Human Society

The next gap which Engels recognised was that in the development of human society from the animal stage, but it was not sufficient on this point to see and appreciate at their true value the results of scientific workers: here Engels was a scientist on his own account. The prevalent popular view in the 19th century was still that of the special creation of man. The materialists, led by Darwin, Huxley and Haeckel, maintained that man was only a superior ape distinguished by a larger brain. This brain which gave man his peculiar character was just such a product of evolution as a bat's wings or an elephant's trunk. Engels and Marx saw this crude explanation was hardly better than the theological one. They saw, long before anthropologists had taken up the question, that there was something qualitatively different about man which distinguished him from other animals, and that this was not an immortal soul, but the fact that man does not exist apart from society, and is in fact a product of the society which he has himself produced. Men, by entering into productive relations with each other, by the first exchange of food, and by the transmission of social characters through the family, became qualitatively different from other animals. These subjects were dealt with by Engels in an essay on "Work as the factor making for the transformation of Apes into Men," and in his most brilliant scientific work, *The History of the Family.*

V. L. Komarov, in his article on "Marx and Engels on Biology"[11] discusses at length this very point. The first stages, the development of man as a tool-using animal and as an animal capable of communicating with his fellows, can only be looked at from the biological point of view. It is at the same time the anatomical possibility inherent in a tree ape that has become a ground ape that make the use of instruments possible, and the use of instruments make the development of the human hand into its present form possible, without which it must have developed either hoofs or paws:

> So the hand is not only an organ of labour; it is also its product…. But the hand was not something self-sufficient: it was only one of the members of a complete and unusually complex organism, and what assisted the hand also assisted the whole body which the hand served, and assisted it in a double respect. (M.E.A., Vol. 2, p. 201.)

But at the same time, the development of manual skill interacted with the formation of primitive society.

> The development of labour necessarily assisted the closer drawing together of the members of the society since

[11] *Marxism and Modern Thought.*

> because of it instances of mutual support and of common action became more frequent and the advantage of this mutual activity became clear to each separate member. To put it shortly, men when formed, reached the point when they felt the need of saying something to one another. The need created the organ. The undeveloped tongue of the ape was slowly but steadily changed by means of gradually increased modulations and the organs of the mouth gradually learned to pronounce one distinct sound after another. (V. L. Komarov, *Marxism and Modern Thought,* p. 201).

The Origin of the Family

In *The History of the Family* Engels takes up the story again at a later stage. It is here that the full value of Engels as a scientist can be appreciated. Long before its recognition by the official anthropologists, he appreciated the significance of the matrilinear family group or clan that travellers and missionaries were showing to exist among all primitive peoples. With his wide historical learning he linked these facts with the history of early Greece and Rome, and showed first of all what an admirable economic unit the matrilinear family was at a certain primitive stage of production, and secondly how it broke down first to the patriarchal family, and finally to the modern small family, under the influence of the development of property, itself due to better methods of production. All the more recent work of anthropologists and historians has only served to confirm Engels' original ideas. The transformation from the matrilinear family to the present form has been traced also in China and can be seen in actual course of operation in all primitive societies in contact with European civilisation, as Malinowski in particular has shown in great detail. Engels' anthropological studies were not merely academic exercises: they were closely related to the great task that he shared with Marx, the transformation of capitalist into socialist society. In recognising the relatively happy, courteous, and upright life of savages compared to their civilised descendants, he conceives the task of socialism as that of the return, again through the negation of the negation, to the nobility of the savage, without the sacrifice of the material powers which capitalist development had presented to mankind. His historical studies, particularly *The History of the Mark,* all led to the effecting of this transformation. He realised its difficulty (Letter 227): –

> History is about the most cruel of all goddesses, and she leads her triumphal car over heaps of corpses, not only in war, but also in "peaceful" economic development. And we men and women are unfortunately so stupid that we never can pluck up courage to a real progress unless urged to it by sufferings that seem almost out of proportion.

Engels' Work and the Development of Science

What is the relation of Engels' work to the enormous development of science that has gone on since his time? What has already been said should be sufficient to show that this has only confirmed the value of his methods of approach and suggested their further application. For part of the intervening period this has been done by Lenin in *Materialism and Empirio-Criticism,* or by the writings of Plekhanov and Bukharin. At the moment this work is being carried forward both theoretically and practically by the younger Soviet scientists.[12]

There is no doubt that Engels would have recognised and welcomed the main advances in the scientific field which have occurred since his time. He would have recognised that four significant steps have been taken. The Relativity theory has finally dethroned the mechanical materialism of the Newtonian school, but only in its mechanical and not its materialist aspects. Engels, who welcomed the principle of the conversion of one form of energy into another, would equally have welcomed the principle of the transformation of matter into energy. Motion as the mode of existence of matter would here acquire its final proof. The second great advance, the whole modern atomic and quantum theory, would also appear to him as a vindication of dialectical materialism. The diverse qualities of the natural elements now find their explanation simply in the number of electrons which compose them. Even more clearly than in organic chemistry, the transformation of quantity into quality is exemplified. The great advances in bio-chemistry which show the phenomena of living animals and plants as functions of the properties of the chemical molecules which make them up is a direct ex-

---

[12]See for instance, Science at the Cross-roads (Kniga 1931); and Science and Education in Soviet Russia, by A. Pinkevitch (Gollancz); and Marxism and Modern Thought, already quoted.

emplification of what Engels had written about the chemical basis of life. Finally, the discovery of the mechanism of inheritance through the chromosome theory (originally put forward by Mendel and now actually verifiable by microscopical observation) provides the material mode of transformation by which living animals develop and reproduce. These advances leave the main gaps in our knowledge still open, but we see more clearly than Engels could how they are likely to be filled. Nevertheless, Engels' work remains not only notable in its own time, but as valuable to us now in trying to keep the same all-embracing and historical approach to science that he possessed, and to use the methods he elaborated in pushing forward the solution of further problems.

After half a century of neglect, the methods of Engels and Marx are at last coming into their own in the scientific field. First, in the Soviet Union, but already also in England and France, the classics of dialectical materialism are being studied for the light they throw on present problems. In France in particular there have already appeared two notable contributions in *A la Lumiere du Marxisme* (In the Light of Marxism) by a number of scientific writers and historians, and *Biologie et Marxisme* by Prenant. The crises of modern science appear in the first place as intellectual difficulties arising from new and apparently incompatible discoveries. The resolution of these crises, that is, the process of bringing them into harmony with the general movement of human thought and action, is a task for the Marxist scientists of to-day and to-morrow. The task is an endless one, and yet definite stages of advance can be established. We have through dialectical materialism a greater comprehension of whole processes, which before were only seen in their parts.

But it is not only in these general, almost philosophical, aspects of science that Engels' work is of value. In everyday work, those who take the trouble to follow Engels' hints find themselves more able to grasp the detailed connections of special investigations. The function of dialectical materialism is not to take the place of scientific method, but to supplement it by giving indications of directions in which hopeful solutions may be looked for. As Uranovsky says in *Marxism and Modern Thought:*

> The dialectic of nature is a method of the investigation and understanding of nature. This conception of nature is founded on the application of materialist dialectic to the da-

> ta of science as they are obtained at each given historical moment. The dialectic of nature brings no artificial connections into nature and does not solve problems by substituting itself for the natural sciences. It helps in critically understanding and connecting facts already obtained, it points out the paths of further investigation and fearlessly poses uninvestigated problems. (p. 153.)

It is for the scientific method to judge whether these solutions are or are not true.

By showing how science has grown up as it were unconsciously in relation to these productive forces, it shows at the same time how this unconscious purpose, once grasped, can be consciously directed. This is what is happening in the U.S.S.R., and, once fully in action, it will be found that science has reached a new plane in its development.

But that stage will not come of itself; it will require intelligent collaboration on the part of the scientists themselves. In doing this they will make the memorial to Engels which is most in keeping with his spirit. For Engels was more than a scientist and a philosopher; he was a revolutionary. With him science acquired a new and positive meaning. As the last thesis on Feuerbach has it:

"The philosophers have only interpreted the world in various ways. The point, however, is to change it."