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INTERPRETATION OF SCIENCE[1]

By Sir RICHARD GREGORY, Bart., F.R.S.

EDITOR OF *Nature*

THE address given by me last year, on "Science in the Public Press,"[2] was largely a plea for increased attention to scientific subjects in newspapers and other periodicals. It was suggested that there is a wide-spread interest in scientific discoveries and conceptions and that encouragement should be given to the production and distribution of articles in which such developments are made intelligible and acceptable to general readers. Appreciation of what is important in news of this kind requires a scientific training, while journalistic experience and a feeling for good literary style are desirable for popular treatment of the available matter. Considerations such as these are concerned in the preparation of scientific articles which will appeal to thoughtful readers among the general public.

In addition to this "literature of knowledge," there is, following De Quincey's division, the "literature of power," by which he meant poems and other writings which survive because of their beauty of expression, as distinct from information which is continually being revised and expanded. By this standard, however brilliant the exposition of a scientific subject may be, it is not considered to be what is commonly known as literature unless it represents emotional response to what is perceived or experienced. It is true that a passage from one of Sir James Jeans's books appears in the thousand pages of literary extracts included in "The Oxford Book of English Prose," but this is the

[1] Address at the twelfth annual conference of the Association of Special Libraries and Information Bureaux, London.

[2] Printed in the issue of SCIENCE for October 12, 1934.

only one representing an aspect of modern scientific thought.

In literary circles it seems to be commonly believed that the pursuit of scientific knowledge produces a cold and mechanistic type of mind altogether opposed to the throbbing and compassionate heart of life to which literature aims to respond. Even the knowledge itself is regarded superciliously because it can not claim to belong to the eternal verities. "The gods are dead," wrote W. E. Henley.

> The world, a world of prose,
> Full-crammed with facts, in science swathed and sheeted,
> Nods in a stertorous after-dinner doze!
> Plangent and sad, in every wind that blows
> Who will may hear the sorry words repeated:—
> "The Gods are dead."

It is true that the old idols of wood and stone are gone, but far nobler conceptions have taken their place. The universe no longer consists of a few thousand lamps lit nightly by angel torches, but of many millions of suns moving in the infinite azure, into which the mind of man is continually penetrating further. Astronomy shows that realms of celestial light exist where darkness was supposed to prevail, while scientific imagination enables obscure stars to be found which can never be brought within the sense of human vision, the invisible lattice work of crystals to be discerned, and the movements of constituent particles of atoms to be determined as accurately as those of planets around the sun. The greatest advances of science are made by the disciplined use of imagination; but in this field the picture conceived is always presented to nature for approval or rejection, and her decision upon it is final. In contemporary art, literature and drama, creative imagination may be exhausted, but not in science, which can provide hundreds of arresting ideas awaiting beautiful expression by pen and pencil. With one or two brilliant exceptions, popular writers of the present day are indifferent to the knowledge gained by scientific study, and unmoved by the message which science alone is able to give. Unbounded riches have been placed before them, yet they rarely raise their eyes from the primitive refuse heap. Not by their works shall we become "children of light," but by the indomitable spirit of man ever straining upwards to reach the stars.

Science needs not only writers to make its achievements intelligible to general readers, but also poetic and other interpreters who will expound its intent and influence by artistic representation or performance. It is to such literary and similar interpretations of ascertained knowledge that this address is devoted, and not to purely scientific description, however admirable and accurate this may be. Several years ago the separation of the scientific and the esthetic sides of culture was commented upon in the report of a committee of the then Prime Minister on "The Teaching of English in England," and the hope was expressed that the two might be more closely united.

> We have a traditional culture [the Committee said] which comes down to us from the time of the Renaissance, and our literature, which is rich, draws its life-blood therefrom. But the enormous changes in the social life and industrial occupations of the vast majority of our people, changes in the sixteenth century and greatly accentuated by the so-called Industrial Revolution, have created a gulf between the world of poetry and the world of everyday life from which we receive our "habitual impressions." Here, we believe, lies the root cause of the indifference and hostility towards literature which is the disturbing feature of the situation, as we have explored it. Here too lies our hope, since the time cannot be far distant when the poet, who "follows wheresoever he can find an atmosphere of sensation in which to move his wings," will invade this vast new territory, and so once more bring sanctification and joy into the sphere of common life.

Writing, at the beginning of the nineteenth century, Wordsworth similarly looked forward to the time when the poet would find inspiration in aspects of scientific achievement and industrial progress. He suggested that:

> The remotest discoveries of the Chemist, the Botanist, or Mineralogist, will be as proper objects of the Poet's art as any upon which it can be employed, if the time should ever come when these things shall be as familiar to us, and the relations under which they are contemplated by the followers of these respective sciences shall be manifestly and palpably material to us as enjoying and suffering beings. If the time should ever come when what is now called science, thus familiarised to men, shall be ready to put on, as it were, a form of flesh and blood, the Poet will lend his divine spirit to aid the transfiguration, and will welcome the being thus produced, as a dear and genuine inmate of the household of man.

The suggestion in these extracts is that poetry, like other forms of art, should follow on the heels of knowledge. During one period in the history of English poetry there was almost a total absence of intimate knowledge of natural objects and events obtained by personal observation. Nature was interpreted as gardens and green fields, with birds singing and shepherdesses dancing, but the interest was sentimental rather than scientific; that is to say, little evidence was shown of first-hand knowledge of objects and events in the world around us.

Some of the greatest poets have, however, enriched their verse by the study of natural phenomena—Lucretius, Milton, Dante and Goethe, for example, each made accurate use of the scientific knowledge of their

times. In English poetry dealing with nature—the countryside as apart from precise science—Thomson in his "Seasons" brought about a great development of interest in the natural world related to universal human nature. Even closer contact was revealed by Wordsworth, who accepted divine thought as pervading all nature and the poet as responding to the moods with which he was in close communion.

Keats and Shelley, Tennyson and Browning all saw beauty and power in nature, and each has given us works in which great poetic perceptions are mingled with passionate human feeling. Keats by perfect phrase and exalted fancy expressed the poetic love of nature for her own sake, as in his thoughts on the song of the thrush in "Nature's Child":

> O fret not after knowledge!—I have none,
> And yet my song comes native with the warmth.
> O fret not after knowledge!—I have none,
> And yet the Evening listens.

Shelley, on the other hand, in "Queen Mab," written when he was only eighteen years of age, showed himself to be acquainted with existing knowledge of the sun and stars, the structure of the universe and other astronomical studies. Similarly, Wordsworth as the contemplative lover of nature differs from Tennyson, who observed her features in minute detail and recorded them with faithful affection. In his felicitous combination of science and poetry Tennyson reveals naturalism at its highest and best. Robert Bridges in "The Testament of Beauty" similarly shows how observations of nature and science may be presented in classical literary style and illustrate that "This spiritual elation and response to Nature is Man's generic mark."

Though poetry and science represent different attitudes towards nature, they are not mutually destructive and may be complementary to one another. The purpose of poetry is not to present facts, but to express stimulating thoughts in a perfect setting of words. While science seeks to secure uniformity in verifiable truths, the essence of poetry is diversity of conception. To the scientific imagination the atom is a microcosm in which the movement of each electron plays a particular part; and it is upon the nature and consequences of the movements of such particles that attention is concentrated. The desire is to see things as they are, whereas the poet aims to display the emotional feelings aroused by them. Coleridge defined the difference between the two types of mind when he wrote: "The proper and immediate object of science is the acquirement or communication of truth; the proper and immediate object of poetry is the communication of pleasure."

The two intentions are not, however, necessarily opposed. It is common to-day to disparage Victorian verse, yet no poet has surpassed Tennyson in the application of scientific truth to poetic purpose or in his wealth of allusions arising out of a knowledge of nature's operations and laws. Interest in scientific studies increased his range of selection and opened his eyes to new phenomena and ideas. His poems abound in descriptive beauty, and though many are so well known as to have become almost trite, yet it is permissible again to quote a selection from them to show how nature knowledge may be successfully united to poetry. What a perfect picture of the last stage of metamorphosis of an insect is afforded, for example, by the words from "The Two Voices":

> To-day I saw the dragon-fly
> Come from the wells where he did lie.
>
> An inner impulse rent the veil
> Of his old husk: from head to tail
> Came out clear plates of sapphire mail.
>
> He dried his wings: like gauze they grew;
> Thro' crofts and pastures wet with dew
> A living flash of light he flew.

The constellation of Orion, which commands attention in the sky at night during winter months, approaches the setting sun as spring comes on and is eventually lost in the twilight. This is a mere statement of common observation, but in "Maud," Tennyson paints the scene with the brush of an artist;

> It fell at a time of year
> When the face of night is fair on the dewy downs,
> And the shining daffodil dies, and the Charioteer
> And starry Gemini hang like glorious crowns
> Over Orion's grave low down in the West.

There are many poetic descriptions of the midnight sky, the changing moon, morning and evening stars and other obvious aspects of the heavens, but few reveal even an elementary acquaintance with what is known of these celestial bodies. Tennyson was not only an observer, but was also familiar with current astronomical thought about the stellar universe and the formation of the solar system. The evolution of worlds by the contraction of a mass of gas is given poetic expression in several of his works, as, for example, in his notes on "The Palace of Art," where the lines appear:

> Regions of lucid matter, taking form,
> Brushes of fire, hazy gleams.
> Clusters and beds of worlds, and bee-like swarms
> Of suns, and starry streams.

Though the nebular hypothesis, which was evidently in Tennyson's mind when he wrote these lines, has had

to be revised in the light of new knowledge, his phrases are still perfect descriptions of what can be seen in the heavens.

Milton shows in many places that he was in contact with some aspects of the new philosophy of his time. Galileo's observations of mountains and plains on the moon, revealed to him through his small telescope when Milton was a child, are referred to by the poet in "Paradise Lost," where Satan's shield is compared to

> The moon, whose orb
> Through optic-glass the Tuscan artist views
> At evening from the top of Fesolé
> Or in Valdarno, to descry new lands.
> Rivers or mountains in her spotty globe.

Milton must also have known of Galileo's discovery of the true nature of the Milky Way when he beautifully described this celestial girdle as:

> A broad and ample road, whose dust is gold
> And pavement stars, as stars to thee appear,
> Seen in the galaxy, that milky way,
> Which nightly, as a circling zone, thou seest
> Powdered with stars.

Ancient philosophers speculated and disputed on the constitution of this belt of milky brightness which stretches across the sky at night, but it was not until the invention of the telescope that its true character became known. "By the irrefragable evidence of our eyes," said Galileo, "we are freed from wordy disputes upon this subject, for the Galaxy is nothing else but a mass of innumerable stars planted together in clusters."

It may justly be maintained that scientific truth is not an essential quality of good poetry, which seeks not to unveil mystery but to express it in imagery. There is thus much that appeals to those with poetic instincts in calling the Milky Way the River of Heaven, as do the Chinese and Arabs, or the Path of Souls, as do some North American Indians. Among the ancients a variety of similar beliefs prevailed, one being that a star which escaped from its appointed place set light to the whole space it passed over in its circular course, and so formed the Milky Way. These conceptions were not, however, put forward as imaginative poetry, but as philosophical explanations of what was observed. The Greek philosophers were the men of science of their day, and their ideas were often expressed in verse. Had the Greeks known that the Galaxy consists of innumerable faint stars, they would have been saved from such primitive speculations and one of their poets or philosophers might have forestalled Milton in his beautiful description of it.

It is now known that the Milky Way traces out the general shape of our star system and represents a mass of about a hundred thousand million suns. The sun, with the earth and the other planets, is at a little distance from the center of this congeries of stars, which has the shape of a flattened disk or wheel. We are looking towards the edge of the disk when we see the Milky Way, so that there is an apparent concentration of stars in the direction of the greatest extension of our stellar system. There is substantial evidence that hundreds of thousands of similar systems exist far beyond the limits of the Milky Way, so that our celestial archipelago is only one of an immense number distributed through space. The majesty of the heavens inspired the poetic genius of Job, expressed in such words as "Is not God in the height of Heaven? and behold the height of the stars, how high they are." The mind of man now comprehends a far greater universe of stars, but there has been little emotional interpretation of this wonder in poetic or other literature.

A perfect example of poetic expression applied to a common natural phenomenon is afforded by a sonnet on a shooting star which appeared some years ago in an American magazine, and impressed itself upon my memory, though the title of the magazine and name of the author have been forgotten. The appearance of a shooting star is due to a small portion of cosmic matter, often no larger than a pea, being drawn into the earth's atmosphere and being consumed through the intense heat produced by its rapid movement. In the following verse the poet, while accurately describing what occurs, brings human feeling into the expression of it, and it is his thought rather than the explanation which makes his verse beautiful.

> Far better 'tis, to die
> the death that flashes gladness,
> than alone, in frigid dignity,
> to live on high.
> Better, in burning sacrifice,
> be thrown against the world
> to perish, than the sky
> to circle endlessly,
> a barren stone.

Another fine example of the transformation of a scientific fact into poetic beauty is afforded by Francis Thompson's lines:

> All things by immortal power
> Near or far,
> Hiddenly
> To each other linkèd are,
> That thou canst not stir a flower
> Without troubling of a star.

It required a poet thus to apply the universal law of gravitation to human influences, and to touch the heart while giving a thought upon which even a mathematician may well ponder.

Poetry is not, indeed, the expression of logical

thought or scientific principle, but rather the revelation of human feeling and the art of combining words in meter and phrase which impress the mind in much the same way as music. Campbell did not want "proud philosophy" to teach him the beauty of the rainbow and Keats set forth the same doctrine that "all charms fly at the mere touch of cold philosophy," yet a poet familiar with the optics of rainbow formation might well find in them a source of inspiration. Just as emotion does not manifest itself in exactly the same way in any two minds, so every one sees a different rainbow and is the sole center of the "triumphal arch" which he sees. The particular display of colors admired by him is for him alone, and millions of raindrops falling through the air contribute to his pleasure by their refractive effect upon sunlight. To attempt to explain the formation of a rainbow in verse would not be poetry, but a literary outrage, yet the natural events which lead to a consciousness of the wonder furnish a worthy theme for a muse with poetic insight.

If the attitude presented by Keats and Campbell were true, its consequence would be to deprive every student of elementary optics of the possibility of enjoying the sight of a rainbow. It would be just as illogical to suppose that appreciation of music must be denied to all who have a knowledge of acoustics, or that when a chemist knows the constitution of a synthetic perfume he loses his sense of smell. Knowledge does not necessarily prevent poetic conceptions or strangle imaginative thought. All that it does is to place mystery on a different and a higher plane, and for a single wonder it substitutes a thousand for interpretation by poetic imagery.

It can scarcely be said that Wordsworth's vision has come true and that literary genius has found inspiring themes in the great achievements of modern science. John Davidson, however, in his "Testament" made some remarkable references to the structure of matter and the transition of substance to a condition of self-consciousness. But while so few of our masters of literature are responsive to results of scientific study, a rich field from which precious gems of thought could be derived is neglected. Among men of letters who have brought the human spirit into scientific themes in works of prose are Thomas Hardy, H. G. Wells, Sinclair Lewis and Aldous Huxley. Also, in the works of George Meredith, John Masefield, Laurence Housman and some other leaders, the fringe of such knowledge is occasionally the source of poetic expression. Fuller response to the growth of observational knowledge is found in Alfred Noyes, who, in the three volumes of "The Torch Bearers," has given us a stimulating epic of scientific discovery relating to the heavens, the earth and man's control of natural forces. There is no lack in this work of appreciation of the devotion of scientific pioneers to the cause of truth and their influence for good throughout the ages.

With such faithful and unrewarded investigators in mind, we recollect that Coleridge devoted one of his sonnets to Joseph Priestley, the discoverer of oxygen and pioneer in the experimental study of gases. Priestley's advanced views on theological and political subjects were so unpopular that in 1791 a mob fired his Unitarian chapel and sacked his house, causing him to seek safety in London. Three years later he emigrated to America, where he lived for ten years until his death. When Priestley left England, Coleridge was a young man of twenty-two and the sonnet was probably written at that time. It contains the lines:

> Though roused by that dark Visir riot rude
> Have driven our Priestley o'er the ocean swell;
> Though Superstition and her wolfish brood
> Bay his mild radiance, impotent and fell;
> Calm in his halls of Brightness he shall dwell;
>
> . . . . . .
>
> And from her dark retreat by wisdom won,
> Meek Nature slowly lifts her matron veil
> To smile with fondness on her gazing son!

It is not surprising that Priestley's departure from his native land should have aroused the sympathy of such a strong democrat as Coleridge. The cause of intellectual freedom has not, however, found a similar apostle among poets to-day when Einstein and hundreds of leaders in science, art and literature have been driven from the country of their adoption, in suffering and in shame, to find homes in other lands. If oppression and injustice can still stir the strings of the human heart, surely here is a theme for a poem which will live when the exiles who are now sorrowing by the waters of Babylon will have passed away.

This reference to Coleridge's tribute to Priestley, and the possible awakening of similar emotional response to-day, is, however, only incidental to the purpose of this address. There is no lack now of accurate description and graceful phrasing in poetic and other literature dealing with what may be called natural history subjects. It can not be said, however, that the intellectual horizon of men of letters generally has been extended by advances in modern science. There is not much evidence in the works of leaders in literature of assimilation of the new knowledge or even of the slightest sympathy with it. Occasionally, one finds a reasonable attitude towards the age of science and invention in which we live, but more usually there is an absence of an outlook which will regard science not merely as a storehouse of facts to be used for material purposes, but as one of the great human endowments to be ranked with art and religion, and the guide and expression of man's fearless quest for truth. "If we live in an age of mechanism," said "The Road-

mender of Michael Fairless, "let us see to it that we are a race of intelligent mechanics; and if man is to be the Demon of a machine let him know the setting of the knives, the rise of the piston, the part that each wheel and rod plays in the economy of the whole, the part that he himself plays, cooperating with it."

The machine has always been regarded as a soul-destroying agency, and one of the reactions is to escape from it and return to primitive conditions of life. This cult of romanticism has been the theme of many idylls in which the beauties of nature and the simple pleasures of country life are presented as ideal conditions of human existence. The machine itself is condemned instead of the selfish and unsocial uses made of its power. The greatness of scientific discovery and mechanical ingenuity is naturally overlooked because of sympathy for the working classes who have been exploited to secure industrial success and profits. The story of the development of the machine and its influence upon the cultural forms of western civilization is brilliantly told by Mr. Lewis Mumford in his work entitled "Technics and Civilisation," published last year. Here we have not merely an account of mechanical contrivances and the part they played in the industrial revolution, but a history of the machine and its social and esthetic influences over a period of a thousand years. The distinguishing characteristic of the volume is the attention given to mechanism as an element of human culture, how the perception of its meaning may be interpreted in painting and sculpture, so that art, and literature also, may be freed from the romantic prejudice against the machine as necessarily hostile to the world of feeling. Science and its effect upon invention and mechanization have created a new environment which can be shaped to satisfy man's intellectual as well as his material needs.

> The sensitive apprehension of this new environment [says Mr. Mumford], its translation into terms which involve human affections and feelings, and that bring into play once more the full personality, became part of the mission of the artist; and the great spirits of the nineteenth century, who first fully greeted this altered environment, were not indifferent to it. Turner and Tennyson, Emily Dickinson and Thoreau, Whitman and Emerson, all saluted with admiration the locomotive, that symbol of the new order in Western Society. They were conscious of the fact that new instruments were changing the dimensions and to some extent, therefore, the very qualities of experience; these facts were just as clear to Thoreau as to Samuel Smiles; to Kipling as to H. G. Wells. The telegraph wire, the locomotive, the ocean steamship, the very shafts and pistons and switches that conveyed and canalised or controlled the new power, could awaken emotion as well as the harp and the war-horse; the hand at the throttle or the switch was no less regal than the hand that had once held a scepter.

How a machine in action can give the impression of rhythm, precision, efficiency and duty, working in harmonious unity, is strikingly illustrated in Mr. Rudyard Kipling's poem "M'Andrews' Hymn," in the course of which the chief engineer of a steamship replies to a passenger who has suggested that steam has spoiled the romance of the sea.

> Romance! Those first class passengers they like it very well,
> Printed and bound in little books; but why don't poets tell?
> I'm sick of all their quirks and turns—the loves and doves they dream—
> Lord, send a man like Robbie Burns to sing the Song of Steam!
> To match wi' Scotia's noblest speech yon orchestra sublime
> Whaurto—uplifted like the Just—the tail-rods mark the time.
> The crank-throws gin the double bass, the feed pump sobs and heaves
> An' now the main eccentrics start their quarrel on the sheaves!:
> Her time, her own appointed time, the rocking link-head bides,
> Till—hear the note?—the rod's return whings glimmerin' through the guides.
> They're all awa'! True beat, full power, the clangin' chorus goes
> Clear to the tunnel where they sit, my purrin' dynamoes.
> Interdependence absolute, foreseen, ordained, decreed,
> To work, ye'll note, at any tilt an' every rate of speed.
> Fra skylight-lift to furnace bars, backed, bolted, braced an' stayed.
> An' singing like the Morning Stars for joy that they are made;
> While, out o' touch o' vanity, the sweating thrust-block says:
> "Not unto us the praise, or man—not unto us the praise!"
> Now, a'together, hear them lift their lesson—theirs an' mine:
> "Law, Order, Duty and Restraint, Obedience, Discipline."—

That is the best illustration of what I understand by interpretation of mechanized science; and neither it nor any like it is usually to be found in anthologies of verse or prose. Among men of science themselves there are several who have passed from the laboratory into the garden of poetry and have successfully cultivated beautiful flowers in it, while others have shown themselves masters of English prose. Most scientific workers know well enough how science touches art and music, how it may enter into literature and how it makes history, but there is not like appreciation of its meaning from representatives of beauty and truth in other fields. It is to promote a closer relationship that this address has been written, so that knowledge

and the artist's response to it may be complementary to each other. William Watson expressed their spiritual unity in his verse

> Science and Art, compeers in glory,
> Boast each a haunt divine.
> "My place is in God's laboratory"
> "And in his garden, mine."

To the worker in the laboratory or observatory, however, it would be encouraging if the poet would occasionally stray into his domain and show interest in what is being done to understand structures and processes in nature. A few years ago, Mr. Kenneth Knight Hallowes undertook a detailed literary research with the view of finding what had been done to develop poetry of science since Wordsworth's forecast of its future, and he described his result in an essay published in a small book entitled "The Poetry of Geology," as well as in his complete "Poetical Works." A strong appeal is made in this essay for the creation of a new school of poets of science, who will employ their genius to interpret scientific truths with accuracy and charm.

Any such poetry must embody new conceptions and creative thought vibrant with human feeling and not be mere photographic images or phonographic records of phases of scientific knowledge. While it is to be regretted that achievements of modern science have failed to inspire contemporary poets, we realize fully that the human heart will not be touched by soulless descriptions of natural events or phenomena. "Poetry," said Leigh Hunt, "is the utterance of a passion for truth, beauty and power, embodying and illustrating its conceptions by imagination and fancy." There can be no inspiring poetry of science without the possession of these spiritual attributes and the artistic instinct which will clothe them in garments of blissful words and radiant phrases. When the poet of science does arise, he will probably not have had a specialized scientific training, but his mind will be sensitive to the wonder of scientific discoveries and the insight they afford into natural things from the atom to the celestial universe. Through appreciation of these revelations he will be uplifted to planes of creative thought and sublime interpretation.

SCIENTIFIC EVENTS

THE SECOND INTERNATIONAL CONGRESS FOR THE UNITY OF SCIENCE

THE second International Congress for the Unity of Science will take place in Copenhagen, from June 21 to 26. The central topic will be the relation of physics and biology (including psychology), with especial emphasis upon the concept of causality. A small number of invited speakers will provide the context for a general discussion. Professor Niels Bohr will participate in the congress.

Inquiries and notices of intended attendance at the congress may be directed to the secretary, Dr. Otto Neurath, Mundaneum Institute, 267 Obrechtstraat, The Hague, Netherlands. The subscription for active membership is a hundred francs.

The International Committee in charge of the annual congresses now consists of: M. Boll, Niels Bohr, P. W. Bridgman, Bonnet, Carnap, E. Cartan, J. Clay, M. R. Cohen, F. Enriques, P. Frank, M. Frechet, F. Gonseth, J. Hadamard, P. Langevin, Lashley, Lewis, Lukasiewicz, R. v. Mises, Morris, Neurath, Nicolle, C. K. Ogden, J. Perrin, Reichenbach, Abel Rey, Rist, Rougier, Bertrand Russell, Schlick, Stebbing, Woodger.

The *Proceedings* of the first congress, held at the Sorbonne in September, 1935, and devoted to the general topic of the logic or philosophy of science, are to appear in the early months of 1936 in the form of eight small volumes (Hermann and Co., Paris). A detailed report of the papers and discussions of the congress appears in volume 5, number 6, of the journal *Erkenntnis* (Felix Meiner, Leipzig). Plans are being made to hold one of the congresses in the United States within the next few years.

FELLOWSHIPS IN THE PHYSICAL AND BIOLOGICAL SCIENCES OF THE JOHN SIMON GUGGENHEIM MEMORIAL FOUNDATION

THE following appointments to John Simon Guggenheim Memorial fellowships for work in the physical and biological sciences are announced:

Dr. Harold Francis Blum, assistant professor of physiology, University of California: Appointed for the writing of a monograph on biological photosensitization: research in European laboratories and consultation with European authorities.

Dr. James Thomas Culbertson, instructor in bacteriology, College of Physicians and Surgeons, Columbia University: Appointed for studies of humoral and cellular immunological phenomena in the mechanism underlying the immunity against parasitic diseases, particularly the protozoan and helminthic infestations of man, chiefly at the London School of Hygiene and Tropical Medicine.

Dr. Solomon Gandz, New York City: Appointed for studies of early Arabic algebra, especially its connection with ancient Greek, Babylonian and Egyptian mathematics, and its influence upon medieval European mathematics.

Dr. George Whitfield Deluz Hamlett, research worker,