Coloured thinking and other studies in science and literature / by D.F. Fraser-Harris.

COLOURED THINKING

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AND OTHER STUDIES IN SCIENCE AND LITERATURE

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COLOURED THINKING

AND OTHER STUDIES IN SCIENCE AND LITERATURE

By

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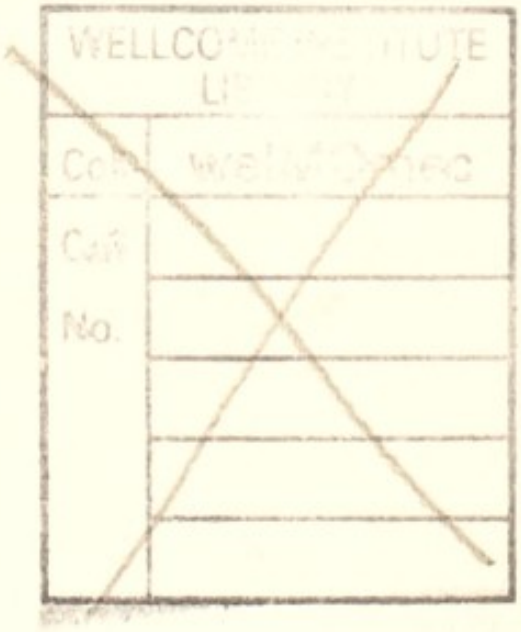

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PREFACE

A COMMON complaint at the present day is that men of science write on their own themes in an unintelligible jargon.

This merely means that the terms of any one science are highly technical and scarcely to be understood by a brother-worker in some other science; far less by the so-called man in the street.

It is probably quite true that many of those who have written on scientific subjects have not taken the trouble to express themselves with that clarity that belongs to true literary form. This has had the two-fold effect of making people imagine that the scientists cannot or will not write pleasant or graceful English, and of hindering the dissemination of scientific knowledge itself.

Both these things are to be deplored, especially the latter. But there is in reality nothing in science to render it incapable of literary treatment, provided always one takes the necessary trouble.

I wish to express my indebtedness to the Editor of *The Cornhill Magazine* for granting permission to reprint the essay "From Thoughts to Things" which appeared in March, 1926. I also have pleasure in thanking the Editors of the *Contemporary Review* for their courtesy in permitting the re-publication of "Childishness in Adult Life" which appeared in June, 1926; and in acknowledging the kindness of Mr H. R. Brabrook of the Religious Tract Society in allowing me to reprint the essays "Science and Character-Building" from the *Sunday at Home* for April, 1926, and "Joy in Discovery" which appeared in September 1927.

Finally, I am indebted to the Editors of the *Birmingham Mail* for allowing me to republish the article "Who said that first?" which originally appeared on March 22nd, 1927; and to Messrs. Hutchinson for permission to use in an expanded form the essay on "Coloured Thinking" which appeared in my book *Science and Life* (Melrose).

D. F. F.-H.

LONDON,
January, 1928.

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I

COLOURED THINKING

There are certain persons in whom sounds are invariably and inevitably associated with colours. Whether these sounds are those of the human voice or the notes of various musical instruments, they are all heard as coloured. This kind of thing is known as coloured hearing ; in French, *audition colorée* ; in German, *farbiges Hören*.

The linking together of any two kinds of sensation is called synæsthesia ; of all the possible synæsthesiæ, the linking of colour and sound is the commonest. A larger number of persons than might be supposed are the subjects of coloured hearing. As long ago as 1864 the chromatic associations of one of these coloured hearers were described by Benjamin Lumley. "I know a person," he wrote, "with whom music and colours are so intimately associated that

whenever this person listens to a singer, a colour corresponding to his voice becomes visible to his eyes; the greater the volume of the voice the more distinct is the colour." This person heard Mario's voice as violet, Sims Reeves' as gold-brown, Grisi's as primrose, and so on.

But there is also a small number of persons who, whether they hear in colours or not, always *think* in colours. These persons, called coloured thinkers, do not have any sensation of colour when voices or notes are heard, but they invariably associate some kind of colour with such things as the names of the days of the week, the hours of the day, the months of the year, the vowels, the consonants, etc. This faculty is coloured thinking or chromatic conception, and has been called psychochromæsthesia. A typical coloured thinker who will tell you, for instance, that Sunday is yellow, Wednesday brown, Friday black, may not experience any sensation of colour on hearing the organ played or a song sung. Certain persons are indeed coloured hearers as well as coloured thinkers; but we should distinguish the person who has linked sensations, a synæsthete, from the person whose

thoughts are coloured, whose mentation is chromatic—who is, in fact, a psychochrom-æsthete.

The literature of synæsthesia is much more extensive than anyone would be inclined to think who had not made it a special study. Nor is the condition described only in technical publications; there is an increasing tendency to recognize it in current fiction. Thus in "Dorian Grey" we have: "her voice was exquisite, but from the point of view of tone is was absolutely false. It was wrong in colour". Musicians, it would appear, are particularly liable to hear in colours: "The aria in A sharp (Schubert) is of so sunny a warmth and of so delicate a green that it seems to me when I hear it that I breathe the scent of young fir-trees". The musical critic of the *Birmingham Daily Post* thus once complained of a lady's singing: "Her voice should have been luscious like purple grapes". *Punch* has, of course, not failed to notice this tendency in musical criticism. A writer in the *Daily Telegraph* had thus expressed himself: "To a rather dark coloured, deep, mezzo-soprano voice, the singer joins a splendid temperament"; *Punch* remarked, "We, ourselves, prefer a

plum-coloured voice with blue stripes, or else something of a tartan timbre ".

Monsieur Peillaube, editor of the *Revue Philosphique*, has reported on four persons who have well-marked coloured hearing for organ notes, and he calls attention to the numerous cases amongst musicians of definite associations between notes and musical instruments on the one hand, and colours on the other as well as between whole pieces of music and colours. Thus Gounod, endeavouring to express the difference between the French and Italian languages and giving his preference to the former, used terms relating to colours : " Elle est moins rich de coloris, soit, mais elle est plus variée et plus fins de tintes ".

Theoretically, any two sensations may be linked, so that coloured hearing is only one particular variety of synæsthesia (coupled sensations, secondary or dual sensations, Secondär-empfindungen). No doubt the linking of colour with sound is the commonest of these dual sensations which, following Bleuler, might be called sound-photisms. When a taste produces light or colours we have a taste-photism ; similarly, there are odour-photisms, touch-photisms, temperature-

photisms, and pain-photisms recorded in the annals of abnormal psychology. A good example of pain-photism is described in a novel, "The Dream Ship". The whole passage is so appropriate to our subject that it may be quoted in full: "Bran" (a boy) "decided all his likes and dislikes by colour and smell. His favourite colours were yellow, red, green, and wet-black. The last was very different to (*sic*) ordinary black, which was the colour of toothache. Little rheumatic pains, which he sometimes got in his knees, were grey. The worst pain you could get was a purply-red one which came when you were sad and gave you the stomach ache. He had once solemnly stated that the only colour he hated was yellow-pink, but as he always called yellow pink and pink yellow, no one had been able to solve the riddle of this hated colour". The black colours of toothache and the grey of rheumatism were this boy's pain-photisms. Something of the reverse order is indicated where a disagreeable colour is described as producing a pain in the stomach. When Baudelaire said that musk reminded him of scarlet and gold, he had an odour-photism.

When the reverse linking occurs, we have

an analogous series as follows: If light or colour produces a sound, it is a light- or colour-phonism: when a taste is coupled with a sound, we have a taste-phonism, and there may exist odour-, touch-, temperature- or pain-phonisms respectively. Sometimes the second sensation linked is of a more vague character, as when screeching sounds produce disagreeable general sensations very difficult to describe. They have been called secondary sensations of general feeling, and they may be akin to those unpleasant sensations evidently experienced by dogs and other animals when they hear music. The late Mr Grant Allen was evidently alluding to this kind of thing when he wrote in an article on "Scales and Colours" that, "Chaos was in dark and gloomy colours, whereas light was treated in white" in such a work as Hadyn's "Creation".

Bleuler believes light-phonisms of high pitch are produced by bright lights, well defined outlines, small and pointed forms; whereas phonisms of low pitch are produced by the opposite conditions. An interesting point may be mentioned in connexion with the difference in colour aroused by spoken words and by whispering. Dr Hélène Stelzner

tells us that in her own case full-toned speech appears as a coloured picture, whereas whispering, with its much less resonant vowels, appears like a copper-plate engraving, that is, as non-chromatic.

Quite apart from all these things—synæsthesiæ—is coloured thinking or chromatic mentation. Here it is not a question of a sensation being present at all, it is that certain persons who have this power, faculty or disability cannot visualize any concept without seeing it in " the mind's eye " as coloured in some way or other. Indeed, the majority of the coloured thinkers questioned by the author do not experience colours when they hear sounds or musical tones, but they cannot think of anything definitely, the month, the day, the hour, without its being thought of as red or yellow or black or white or brown or green or blue. There is no approach towards unanimity in the colours thought of in association with any one concept or word ; for instance, for Saturday the colours selected at random from records in my possession are white, yellow, steel-grey, white-grey, crimson, brown. The coloured thought may be called a psychochrome, and persons who think in colours psychochromæsthetes, the faculty or

disposition to think in colours being psycho-chromæsthesia. Something analogous to this is the case of the blind man alluded to by Locke to whom scarlet was " like the sound of a trumpet ".

Apparently the concepts to be most commonly coloured are those for the vowels, the consonants, the months, the days, and the hours of the day. Thus the vowel " a " as in " fame " is mentally coloured in the following five ways in five different persons—red, black, green, white-grey, and white respectively. Or take the vowel " u " as in " usual ", we find it psychically coloured as grey-white, yellow, black, brown, blue, and green in six different coloured thinkers. Similarly, whole words are associated with colours in the minds of this class of thinkers. One person says he divides all words into two great classes, the dark and the light. Random examples of dark words are man, hill, night, horse, Rome, London, and of light, sea, child, silver, year, day, and Cairo. Or again, another coloured thinker divides up the numerals into those associated with cold colours, grey, black, blue, green ; and those with warm, red, yellow, orange, brown, purple, and pink. The odd numbers have the cold colours ; the even, the warm.

In some cases, as might be expected, the coloured concepts are appropriate or natural as when the word scarlet is scarlet; black, black; and white, white. But an examination of psychochromes shows us that this reasonableness does not necessarily always occur. Thus, the word "apple" is to one coloured thinker a slate grey, which is not the colour of any real apple; and the word "cucumber" to the same person is white; now only the inside of the vegetable itself is white.

Some kind of method, however, may be traced in this chromatic madness, for, according to Bleuler, high-pitched notes produce the lighter tints of colour, but low-pitched the darker shades. According to this authority, the colours oftenest aroused in the synæsthesia, sound-photism, are dark brown, dark red, yellow, and white, which is not at all the statement of the frequency of occurrence of colours in coloured thinking. From the records of the psychochromes of two brothers, the relative order of frequency of the colours is white or grey, brown, black, yellow, red, green, and blue, violet and indigo not occurring. Dr Hélène Stelzner says that green is the colour least commonly thought

of. But individual differences are extreme: thus both purple and violet are such favourites with some coloured thinkers that they hardly ever think in terms of any other colours. The present writer has examined the psychochromes of two men, one woman, and one child, with the result that the relative order of frequency of occurrence comes out as white, brown, black, yellow, green, blue, red, pink, cream, orange, and purple. It is thus clear that the colours thought of are not exclusively the pure or spectral ones, for certain non-spectral colours like brown, pink, cream, white, and black are quite commonly reported.

The novelist, Ellen Thorneycroft Fowler, in a private communication to the author, wrote: "The colour which I always associate with myself, for no earthly reason that I can discover, is blue. Therefore, "E", my initial letter is blue, April the month of my birthday is blue, and 9, the date of my birthday, is blue." This is known as "colour individuation", and has been made a special study of by Paul Sokolov in his paper, "L'individution colorée", read before the Fourth International Congress of Psychology held at Paris, 1900. Some people, in short, have their favourite

colours, and with these they invest their pleasant thoughts, while their unpleasant thoughts they find coloured by the tints they are not fond of.

Apart, however, from whether certain colours are favourites or not, some few persons have the consciousness of a colour more or less present with them. Thus, R. L. Stevenson had, so he tells us, a feeling of brown which, during his attacks of fever, was unusually distinct. It was " a peculiar shade of brown, something like sealskin ".

As might be expected, so acute an observer as Mr Rudyard Kipling has not failed to notice coloured thinking. In his very curious story " They ", he describes the colour concepts experienced by a blind old lady who opens an interview by complaining that certain colours—purple and black—hurt her. Her visitor asks: " And what are the colours at the top of whatever you see? " " I see them so," she replies, " white, green, yellow, red, purple; and when people are very bad, black across the red, as you were just now." The old lady goes on to say that ever since she was quite a child some colours hurt her, and some made her happy. " I only found out afterwards that other people did not see

the colours." So unfamiliar is coloured thinking to the ordinary person that a critic wrote (*The Academy and Literature*, October 8th, 1904): "Such tales as 'They' are sheer conundrums". Another writer asked more pertinently: "Are the colours the blind woman described, the colours of different thoughts?"

In Mrs Felkin's novel, "In Subjection" (1900), the heroine, Isabel Seton, is evidently a coloured thinker. Some of her colour associations are given on page 149. The novelist, in a letter to the writer, was good enough to explain that these experiences of her heroine were based on those of an actual prototype, some of whose additional psychochromes she had kindly mentioned. Isabel Seton had synæsthesia also, for the actual sounds of voices call up colours. Thus, soprano voices were to her pale blue or green or yellow or white; contraltos were pink or red or violet; tenors were different shades of brown; while basses were black, dark green or navy blue.

In the novel "Christopher" by Richard Pryce, there is an interesting allusion to a boy who is described as not morbid, although he is evidently a synæsthete and a coloured thinker. He talks of playing the sunset on the piano (a colour-phonism), and of smelling moon-

light (a light-olfaction). In a novel, "Youth's Encounter", published in the year 1913, we are told that to one of the characters "Monday was dull red, Tuesday was cream-coloured, Thursday was dingy purple, Friday was a harsh scarlet, but Wednesday was vivid apple-green, or was it a clear, cool blue?"

It is difficult to express the character of these coloured concepts to persons—and they are the majority of people—who never experience this sort of thing at any time. The colours are not present so vividly as to constitute hallucinations. Coloured visualizings never become hallucinatory, possibly because they are of the nature of thoughts, rather than of subjective sensations. Chromatic conception belongs to the physiology, not to the pathology of mind. Coloured thinkers are not continually plagued with phantasmagoria. Mental colourings do not obtrude themselves into one's mental life; they are habitual, natural, chromatic tincturings of one's concepts, and have been so long present to consciousness that they have long ago become part of one's mental belongings. They are invariable and definite without being disturbing.

One coloured thinker has thus expressed himself: "When I think at all definitely about the month of January, the name or word appears to me reddish, whereas April is white, May yellow, the vowel 'i' is always black, the letter 'o' white, and 'w' indigo-blue. Only by a determined effort can I think of 'b' as green or blue, for me it always has been and must be black; to imagine August as anything but white seems to me an impossibility, an altering of the inherent nature of things". There is thus an inherent definiteness, finality, and constancy about each thinker's psychochromes that is very striking. But it is not alone letters and words that are habitually thought of as coloured, certain coloured thinkers always associate a particular colour with their thoughts about a particular person.

The author of "The Corner of Harley Street" remarks (p. 251): "If only we could use colours now to express our deeper attitude on these occasions, as some of your fellow clergy wear stoles at certain seasons, with what pleasant impunity could we write to one another in yellow or purple or red, leaving black for the editor of the *Times* or the plumber whose bill we are disputing".

"Our alphabet is not rich enough for the notation of the cockney dialect," writes Mr. Richard Whiting in "No. 5 John Street." "I can but indicate his speech system by a stray word which, if there is anything in the theory of the correspondence between sounds and colours, should have the effect of a stain of London mud." This is evidently an allusion to coloured thinking. There is, unfortunately, no theory at all as yet, but there is the fact of chromatic conception. About fourteen years ago there was in the *British Review* a vivacious article dealing with coloured thinking from the popular standpoint.

The literature that contains the most systematic discussion of coloured thinking is that of the decadent poets of France, the symbolists, as they are called. Some account of their psychochromes is given in Lombroso's "Man of Genius". The eccentric poet, Paul Verlaine, belonged to this school. It evidently includes synæsthetes as well as coloured thinkers, for, for them, the organ is black, the harp white, the violin blue, the trumpet red, and the flute yellow. But they think of the vowel "a" as black, "e" as white, "i" blue, "o" red, and "u" yellow. One of them, Stéphane Mallarmé, has explained in

his pamphlet "Traité du Verbe" how these things have come to be.

The following verses—for one hesitates to call them poetry—seem to be an attempt to express the associations of emotions symbolized by the mental colourings of the vowels :

VOYELLES

A noir, E blanc, I rouge, U vert, O bleu, voyelles,
Je dirai quelque jour vos naissances latentes ;
A, noir corset velu des mouches éclatantes
Qui bombillent autour des puanteurs cruelles.

Golfes d'ombre, E, candeur des vapeurs et des tentes,
Lances des guerriérs fiers, rois blancs, frissons d'ombelles,
I, pourpres, sang craché, rire des lèvres belles
Dans la colére ou les ivresses pénitentes.

U, cycles vibrement divins des mers virides,
Paix des pâtis semés d'animaux, paix des rides
Que l'alchemie imprime aux grands fronts studieux.

O, suprême clairon plein de strideurs étranges,
Silence traversée des Mondes et des Anges,
O, l'omega, rayon violet des ses yeux.

—*J. A. Rimbaud.*

We are now perhaps in a position to make some inquiry into the characteristic features of coloured thinking. The first point that strikes one is the very early age at which these associations are fixed. This was a feature recognized by Galton in his classic examination

of the subject in 1883. The present author's observations fully confirm this point ; he has in his possession many letters from coloured thinkers in which the details of their psychochromes differ in the widest possible manner, but all agree in that they testify to the very early age at which the associations were formed. After the publication of the writer's article in the *Scotsman*, December 29th, 1908, he received a number of letters spontaneously sent, all emphasizing this feature in such phrases as " ever since I can remember ", " ever since childhood I have always had it ", " I do not remember the time when I had not ", etc. A writer in *Nature* in 1891 reports on the psychochromes of his daughter when seven years old, at which age she had specifically different colours for the days of the week, namely : blue, pink, brown or grey, brown or grey, white, white, and black. The months of the year were coloured in the following way by a girl of ten, who had so thought of them ever since she could remember : brown, olive-green, " art " blue, green-yellow, pink, pale green, pale mauve, orange, orange-brown, grey, grey outlined in black and finally red.

A boy ten years old is reported in the article

on Colour Hearing in the *British Review* to have "noticed that the number eight invariably provoked in him the sensation of apricot-yellow, and the number fifteen that of peacock blue". There seems not the slightest doubt that these colour associations are amongst the earliest that are formed in the child mind of the coloured thinker.

The second characteristic of coloured thinking is the unchangeableness of the colour thought of. Middle-aged people will tell you that there has been no alteration in the colours or even in the tints and shades of colour which, for many years, they have associated with their various concepts. Galton remarked on this in his original monograph: "They are very little altered," he said; "by the accidents of education." Galton's phrase was they result from "Nature not nurture". Just as their origination is not due to the influence of the environment, so the environment exercises no modifying influence on them even during a long life.

The third characteristic of psychochromes is the extreme definiteness in the minds of their possessors. Contrary to what might reasonably be expected, the precise colours attached to concepts are by no means vague

or incapable of accurate verbal description. A coloured thinker is most fastidious in the choice of terms to give adequate expression to his chromatic imagery. One of these is not content, for instance, with speaking of September as grey, he must call it steel-grey ; another speaks of a dull white, of a silvery white, of " the colour of white watered silk ", and so on. One child speaks of March as " art blue ", whatever that is ; another of 6 p.m. as *pinkish*. The degree of chromatic precision which can be given by coloured thinkers to their visualizing is as extraordinary as any of the other extraordinary things connected with this curious subject.

The fourth characteristic is the complete non-agreement between the various colours attached to the same concept in the minds of coloured thinkers. Thus, nine different persons think of Tuesday in terms of the following colours : brown, purple, dark purple, brown, blue, white, black, pink, and blue. Again, September is thought of as pale yellow, steel-grey, and orange by three different coloured thinkers respectively. Once more, the vowel " i " is thought of as black, red-violet, yellow, white, and red respectively by five persons gifted with chromatic

mentation. Unanimity seems hopeless, agreement quite impossible; the colours are essentially individualistic.

The fifth characteristic of psychochromes is their unaccountableness. No coloured thinker seems to be able to say how he came by his associations; "I cannot account for them in any way" is the invariable remark one finds in letters from persons describing their coloured thoughts.

The sixth characteristic is the hereditary or at least inborn nature of the condition. Galton's phrase was "very hereditary". The extremely early age at which coloured thinking reveals itself would of itself indicate that the tendency was either hereditary or congenital. The details of a case of heredity from father to son have been reported for coloured hearing by Lauret and Duchassoy; a case of coloured thinking reported by the present writer was one of heredity also from father to son. But these related coloured hearers did not see the same colours for the same sound, nor did the two coloured thinkers think in the same colours. From the writer's inquiries, coloured thinking is certainly congenital even when it cannot be proved to be hereditary. This point will come up again

in connexion with the origin of the condition, but we may at present note that those who have studied the subject are unanimous in denying that at any rate coloured thinking is due to environmental influences.

It may be now asked what manner of people are they who are coloured hearers or coloured thinkers or both. The late Mr Galton told us that they are rather above than below the average intelligence. The writer's observation would, in the main, confirm this; they are at least invariably well educated persons who confess to being coloured thinkers. In his book, Mr Galton gave a few names of distinguished persons of his acquaintance, and his list might be brought up to date by the addition of some names quite as distinguished. But all persons who have coloured hearing or coloured thinking are not necessarily distinguished—a large number, as we have seen, are yet children—but they are all probably more or less sensitive. Possibly they are more given to introspection than is the ordinary person. At any rate, what is quite certain is that both synæsthetes and psychochromæsthetes belong to the group of strong visuals or "seers" as Galton called them. Seers are persons who visualize

or exteriorize their concepts either as uncoloured forms or as coloured in some way or other. The uncoloured thought-forms are very curious, some of which Galton gave as examples in the appendix to his work.[1] One distinguished neurologist always sees the numerals 1 to 100 in the form of a ladder sloping upwards from left to right into the sky. As this concept is not coloured, it cannot be called a psychochrome, but it might be called a psychogram. A psychogram is, then, the uncoloured thought-form of a concept, and people who have psychograms must be strong visualizers.

The school of symbolist poets in France to which Ghil, Malarmé, Rimbaud, and Verlaine belong, appears to lay a great deal of stress on the so-called meaning of colours. The school evidently includes both coloured hearers and coloured thinkers; but whereas the majority of coloured thinkers derive no particular meaning from their psychochromes, the symbolists attach considerable significance to the colours which happen to be associated with their thoughts. The different vowels, for instance, mean to them or represent for them particular emotions or states of mind, not in virtue of the sound

[1] *Inquiries into Human Faculty and its Development*, Macmillan, 1883.

of the vowel, but entirely through the related colour. The particular emotion symbolized by any given colour seems to the ordinary person rather arbitrary if we judge by the details in Rimbaud's poem; but we are aware that there has always been a tendency to represent emotional states in terms of the language of colour. Homer spoke of "black pains"; we constantly speak of a black outlook, a black lie, a white lie, a black record, a grey life, a colourless life, and so on. There is, in fact, growing up in England a school of musicians who hold that it should be possible and pleasurable to represent music chromatically. Whether the general public will ever enjoy silent music seems very doubtful, but it is notorious that most people derive a great deal of pleasure from the display of coloured lights, illuminated vapours, coloured steam, "fairy fountains", Bengal lights, a house on fire, and similar exhibitions in the open air. People undoubtedly do like to see great surfaces or masses vividly coloured as in the rainbow, the sunrise or sunset, the afterglow on snowy mountains, the streamers of the northern lights, and so forth. But whether they would care to have audible music suppressed and

to have offered them a succession of coloured surfaces or patches of colour even following one another in the sequence or rhythm required by music, is open to serious question. Such, however, is the intention of Mr A. W. Rimington, as explained in his book, " Colour in Music ", in which there is much that is true and interesting. " It is undeniable," he writes, " that as a nation our colour sense is practically dormant. . . . Compare our colour sense with that possessed by the Japanese, the Indians, or even the Bulgarians and Spaniards. . . . To my mind, a widespread, refined colour-sense is more important than a musical one." Long before Mr Rimington's work was published, there appeared a little book privately printed at Leith in Scotland called " Chromography or tone-colour music ". The author assigned a colour to each of the notes of the scale thus—do=red ; re=orange ; mi=yellow ; fa=green ; sol=blue ; la=violet-purple ; ti=red-purple.

Many persons have synæsthesia in connexion with musical tones (sound-photisms) ; two cases reported by Albertoni associated blue with the sound of do (C) ; yellow with mi (E) ; and red with sol (G). But it

was discovered that they were colour-blind for red (Daltonism). Now, whereas they could recognize and name the other notes, they could not name g, a disability which Albertoni thinks was related to the Daltonism; he has accordingly called it Auditory Daltonism (*Daltonismus auditivus*), a psychical deafness depending on the red-blindness, since the note to which they were psychically deaf was the one which called up mentally the particular colour, red, to which they were actually blind.

It might be now asked whether we have any explanation of the causes or causal conditions of coloured thinking; why may thoughts be coloured at all; and why should particular thoughts come to be associated with particular colours? Why should only a few persons, less than 12 per cent., be found to be coloured thinkers? The answers, if answers they can be called, are disappointing in the extreme, for we have no satisfactory explanations of any of these matters. The very arbitrariness of the associations defies theoretical analysis.

If it is the function of science merely to describe, then our work is done; but in a subject such as this, to make no attempt

to account for the abstruse phenomena observed would be a distinctly feeble conclusion of our studies. It has been suggested that the case of coloured thinking is no more recondite than the influence of some picture-book or paint-box, which in early life determined for us ever afterwards the colours of certain concepts. Now, though many people do regard their coloured thinking as a childish survival, the picture-books will account for very few of the best established psychochromes. In some few cases, environmental influences do seem to have been causal. Thus, in one case known to the writer, the colour of February as white was accounted for by the influence of the surroundings. The earliest February remembered was snowy, and through the whiteness of the snow the concept of February came to be and ever afterwards remained white. But it is clear that if environmental influences are operative in anything like a large number of cases, the colours for such concepts as the months of the year ought to be far more uniform than they are. No common origin or external source can make one person think of August as white, another as brown and yet another as crimson. If August is

white to one person because it is the month of white harvest, then it ought to be white to all persons capable of receiving any impressions as to the colours of harvest. But to the vast majority of people it is perfectly absurd to talk of August having any colour at all; and to the few who think it coloured, it has not by any means the same colour; all seems confusion.

Monsieur Peillaube has made a suggestion of a different kind as likely to explain some of these colour associations. Monsieur Peillaube became acquainted with a Monsieur Ch—— who had *audition colorée* as well as coloured thinking. Monsieur Ch—— had an excellent memory and was able to submit his conceptions to searching introspection, with the result that he seems to have discovered what may be called the missing link in the associational chain of mental chromatic events. To this coloured thinker the lower notes of the organ were of a violet colour. This seems to have been brought about in the following way: low notes of any kind were sweet and deep (*douces et profondes*), the colour violet is sweet and deep, therefore it came to pass that the low notes were associated with violet. Similarly,

to Monsieur Ch—— the vowel sound of "i" was suggestive of something "vive et gaie", the colour green had always been associated with liveliness and gaiety, therefore he thought the vowel "i" was green. These conclusions were reached only after considerable introspection, for it must be understood that the link between the low notes and the colour violet was by no means an explicit or definite presentation in this person's mind, at the time that Monsieur Peillaube suggested the enquiry. Peillaube's theory, then, is, that these apparently arbitrary and instantaneous linkings of sounds (x) to colours (y) or of thoughts to colours, are really, after all, cases of association of two terms through the intermediation of a third factor an emotional link (l) now subconscious but revivable. The sequence was x-l-y, but in course of time the "l" had dropped out of consciousness leaving the "x" and the "y" apparently indissolubly joined together.

Finally it may be asked, would the capability of coloured thinking cause its possessor to be classed as mentally abnormal. The answer is in the negative. Coloured thinkers may not conform to the usual or most

commonly met with mental type, but they deviate from that type only in the same way that geniuses deviate from it. Inasmuch as they deviate from the normal, coloured thinkers are, of course, abnormal, but there is nothing in them allied to instability of mental balance. Some coloured thinkers may, no doubt, belong to families in which some degree of mental instability is present, or, on the other hand, some relatives of coloured thinkers may possess a high degree of artistic or musical ability, of scientific or philosophical insight, that quality in fact, of genius so exceedingly difficult to define. Genius is something notoriously not conferred by training or education, if not inborn it cannot be acquired; exactly the same may be said of coloured thinking. Our studies have at least shown us this, that it is not in the ordinary type of mental constitution, but in the recesses of the slightly supernormal, that this recondite problem of psychology presents itself for analysis and explanation.

Appendix

Being the psychochromes in an actual case.

a.—blue-white (like a dead tadpole).
b.—dark brown-red.
c.—brighter red.
d.—pea-green.
e.—fawn-yellow.
f.—a yellow, brighter than e.
g.—dark brown, nearly black.
h.—black.
i.—chocolate brown.
j.—a dull red (not the same shade as the other reds).
k.—bright brick-red.
l.—black.
m.—bright yellow.
n.—dark brown (nearly black).
o.—white.
p.—white with just a tinge of blue.
q.—pale blue-green.
r.—black (nearer to h than to l).
s.—white.
t.—mustard colour (ugly).
u.—brown-yellow.
v.—olive green.
w.—red (like c).
x.—green.
y.—an ugly yellow.
z.—very bright scarlet.

Sunday.—red.
Monday.—pea-green.
Tuesday.—fawn yellow.

Wednesday.—black.
Thursday.—fawn (not as bright as Tuesday).
Friday.—green (a very ugly bile colour).
Saturday.—white.

January.—dull red.
February.—fawn.
March.—green mustard colour.
April.—blue white.
May.—sunshine colour.
June.—dull red.
July.—a slightly darker red.
August.—olive green (more yellow than n).
September.—white.
October.—green.
November.—black brown.
December.—a blue shot with green.
Christmas.—white.
Whitsun.—nearly a rose pink.
Easter.—black with something white in the middle.

One.—black.
Two.—blue-white.
Three.—fawn.
Four.—dark red.
Five.—white.
Six.—bright yellow.
Seven.—black.
Eight.—white.
Nine.—green.
Ten.—mustard-green.
Eleven.—brown-yellow-green.
Twelve.—pale brown.

II

CHILDISHNESS IN ADULT LIFE

Most people, if asked to say what characterizes the social life of the present day, would reply, the applications of natural science to our pleasures and convenience; and yet it is abundantly evident that along with these notable and astounding developments of science there is a very great deal of what can only be described as childishness. If ever there was an age when a rational view of knowledge seemed paramount it is the present, and yet co-existent with this there is a vast underlying substratum of the irrationality of the immature mind. The particular variety of mental immaturity of which we are thinking is the incapacity to grasp the universality of the doctrine of cause and effect. The *post hoc* is everywhere mistaken for the *propter hoc*, and this not only amongst the uneducated masses but

amongst those whose training should have disposed them to think far otherwise.

The persistence of superstition in the life of to-day is due mainly to two causes, one the receptivity and suggestibility of minds which have never grasped the meaning of causation, the other the perpetuation of the superstitions themselves through the working of racial psychic momentum. It is chiefly in the female mind that these superstitions are preserved. When women get into a panic because thirteen people are at a table, when they think it unlucky to go under a ladder, to spill salt, to break a mirror, to open an umbrella in the house, to see the moon through glass, a spider in the morning, or to wear green at weddings, they are carrying on into adult life an infantile conception of cause and effect. A very large number of people confuse "chance" in the mathematician's sense with "good" or "bad luck". By "bad luck" they do not mean "chance" as amenable to mathematical analysis, but a malevolent influence which follows them through life, destroys their schemes and ruins their prospects. In fact, they still believe in a modern form of "witch's curse" or the "evil eye".

People who really believe that a horse-shoe hung on the door brings good luck, or that a small figure—usually ugly—stuck on the bonnet of their car as a "mascot" can do anything to ward off bad luck, are still in the stage of those who believed that evil spirits bringing calamities could be frightened away by some particularly hideous image (the idol). The Chinese believe that their crackers and bell-ringing have the same power. The "mascot" of to-day is the idol of the savage or the pagan. But the belief in bad luck as caused by inanimate things and things wholly outside our control is not confined to women; it is stated by a prominent London lawyer that he never arranges for any men among his clients to sign a will on a Friday. This belief in bad luck is, then, not confined to Irish peasants and Chinese labourers, it still flourishes in the drawing-rooms of Mayfair and Belgravia.

The puerilities of some spiritualists with their belief in ghosts, persons possessed of mediumistic, super-normal power, in evil spirits, "emanations", astral bodies, "ecto-plasm", spirit photographs, *et hoc genus omne*, are really representing in the age of science the beliefs that belonged to the

very dark ages before Kepler, Galileo, Harvey, or Newton had ascertained some of the general principles on which the workings of the Universe in general, and the human body in particular, are conducted. The same applies very largely to the childishness about the weather, to old wives' tales and folk-lore about signs in the sky. Those who continue to believe, for instance, that the moon affects the weather, have no notion of the real factors that go to produce meteorological changes, have never understood barometric pressure, pressure gradients, anti-cyclonic and cyclonic types of weather, nor the effects of the temperature of the air and its moisture as the sources of winds.

And yet it may be said: "These people are educated". Possibly; but the fact is that education in itself does not eradicate hereditary tendencies to superstition; education may mask, but it does not abolish, the influence of racial functional momentum. The truth is, however, that many of these people are *not* educated in the real sense of the word; for education is the process whereby we learn how to acquire knowledge rather than the mere acquiring of it. The knowing about things is not being educated; it is

being instructed. Education is the appreciation of the value of knowledge, of its quality rather than its quantity. It is the conviction that we are forced to recognize a rational principle underlying all things. Education is, of course, to be distinguished, but often is not, from civilization on the one hand and culture on the other. And "civilization" is often used as though it were a synonym for culture, which it is not.

Civilization is essentially the substituting for the laborious methods of nature (including one's own and one's slaves' muscular exertions) the labour-saving devices of machinery, whereby life is rendered easier. Since the scientific Renaissance civilization has been essentially the application of the discovery of the laws of the Universe, and of the properties of matter and of energy to the solution of the problem how to secure the leisure necessary for thought and recreation.

Culture is something far beyond both education and civilization. It is the desire that all the activities of mind and body should be interpenetrated by the enjoyment of the beautiful; it is the suffusing of the commonplace with the gracious spirit of beauty until the natural man becomes trans-

figured into a being of a higher and more exquisite order. Clearly culture has to be based on education ; a cultured person must be an educated person, but an educated person need not be a cultured one. You can have an educated devil, and a civilized devil, but you cannot have a cultured one ; for the love of beauty (culture) pervades everything in the life physical, mental and moral. You can have educated savages with the veneer of civilization, but " cultured savages " are a contradiction in terms. Thus the so-called " Teutonic Kultur " was scientific education, not culture at all, for it sacrificed beauty ruthlessly to the supposed exigencies of military necessity. The cultured person dare not destroy beauty ; he realizes too intensely that there is so little of it in the world, and what there is is a joy *for ever*. Civilization without culture is indeed a veneer ; it does not remove the primitive, ancestral, social traits and tendencies which shall endure through the operation of physiological momentum as long as man shall endure.

Now childishness is one of these ancestral traits, and inevitably it will be perpetuated by the same social momentum. It expresses itself even in those highly educated people

who walk about with an iron ring round a finger or a raw potato in their pocket to ward off rheumatism, or who believe that a piece of red flannel has much more efficacy than a white one tied round the neck for sore throat. But are not the masses still children, and still to be amused as such? One may pass over the "Amusements Park" at an exhibition, but for what purpose other than to attract the attention of grown-up children is all this disfiguring of cities at night with flaring electric lights, devices showing the wheels of a motor-car going round or a glass being filled from a gin-bottle? It is a crude, large-scale, visual appeal to childishness in adult life. What a commentary on civilization in Britain after 2,000 years is Piccadilly Circus at night!

Egregious childishness can exist alongside the most marvellous applications of the knowledge of the hidden forces of nature, such as are witnessed, for instance, in wireless telephony, the aeroplane, and the submarine boat. There is no doubt that the amount of exact physico-chemical and biological knowledge diffused among the people is small: many people to-day do really believe the earth is flat, and that the sun goes round it,

although they do not like to admit this belief because there seems to be a general prejudice against it. One very marked mode of expressing the childishness of adults is the uncritical acceptance of the statements in advertisements of "quack" medicines. A great many people will believe anything that is told them sufficiently often with sufficient emphasis. The quantity of impotent drugs swallowed at the present day is enormous. No statements about their omnipotence are too absurd to be accepted, no amount of adverse criticism of their worthlessness carries any conviction.

Some years ago, while the trial involving some disputed point about a patent pill was proceeding, and while it was being demonstrated in court that the pill contained no substance of any efficacy whatever, the notices of the virtues of the panacea continued to appear in the newspapers, and the volume of the sales was scarcely diminished. It is as true to-day as the day when it was written: *Populus vault decipi.* A very great deal of the excessive novel-reading of the present day is nothing more nor less than the revival of the childish love of being "told a story".

The appeal made to a certain type of mind by some phases of religion, such as " Christian Science", or more appropriately, " Eddyism", and some fantastic Transatlantic " isms ", is largely because these minds have arrived at no adequate conception of cause and effect. Only to an uncritical, childish mentality can this sort of thing appeal. While there is no doubt that much good can come from the attitude of mind advocated by Monsieur Coué, yet in some quarters the practical result of his method is perfectly absurd, as when we have seen a number of hopelessly incurable general paralytics mumbling unceasingly through their anarthria: " Every day and in every way I am getting better ". It was pathetic in its hopelessness and puerility; it was childishness *in excelsis*.

A notable expression of childishness in adult life is the way in which women will follow a fashion whether it suits them or not. If the vogue is to build up the hair—congenital or acquired—into a pyramid or to cut most of it off, all save a few discriminating women will follow the fashion uncomplainingly. Forty years ago the decree was to look like a wasp; now it is to appear almost

unidimensional; but whatever it is, it is adopted at the risk of discomfort, and even of pain. Perhaps the most irritating result of trying to look very thin is that no pockets are allowed in any garment, with the result that all things needful are carried in a receptacle which, not being an organic part of the costume, is apt to be lost, stolen, or mislaid with disastrous facility.

The imitative faculty so noticeable in children is responsible for the ease with which a phrase often half understood spreads through the community. Thus the words, "psychological moment", which as a joke were originally tolerable, have been used in season and out of season until the repetition is unbearable. To some extent the phrase is illiterate, for if translated out of Greek it means, "the study-of-the-mind moment". What Oscar Wilde intended his character to say was the critical, right, suitable or opportune moment—no more than that. "Psychological" is not the synonym for any of these terms. Another silly phrase which has caught the fancy of our grown-up children is, "I had a brain wave", when all that is meant is, "it suddenly occurred to me." This is oftenest used by those

who know little or nothing about the brain or about waves. There is a third or fourth-rate type of mind which rejoices in phrases and proverbs such as "the aching void", "the better the day the better the deed", and other superficial non-sequiturs.

Closely allied to this sort of thing is the childishness of shibboleths which flourishes from the reciprocally reinforcing influences of childishness and snobbery. These often go hand-in-hand. It is well known there is no greater snob than the schoolboy, and many adults are still in that stage. Each class has its own shibboleth; and the unreflecting acceptance of one of these, as the final word in all that is right or fitting, is the sign of an undeveloped sense of values and of a crude mentality: it is social Peter-Panism. Many things that pass for humour are the most puerile ineptitudes. Much of the old-fashioned "music-hall" stage humour was in itself so silly that, when separated from the comical dress, attitudes, speech and gestures of the comedian, it became emetical. Each few years develop a new phrase indicative of the inanity of its humour, as when people kept on saying, "Now we shan't be long", "Everything in the garden's lovely",

" A little bit off the top ", and so on in an endless series of cacophonies.

There is much childishness on a large scale in contemporary life when processions pass through the streets of a city with the leaders waving flags. Doubtless these perambulators are intended to impress the public with the importance of their cause or movement, seeing that they have employed the obvious method of muscular locomotion. The childish intolerance which decides that no man shall wear a straw hat before or after a certain day in the year, is an example of childishness in adult life as expressed in an impertinent interference in other people's affairs. From their lack of sympathetic imagination, children are very intolerant. The apparent necessity for " rat " weeks, " swat-the-fly " weeks, " clean-up " weeks, pure milk weeks, fire-prevention weeks, etc., is another proof on a huge scale that we are all children of a larger growth, and that we cannot kill rats or flies, or keep our cellars clean or pasteurize milk as individuals, but must be impelled thereto by the infectivity of a slogan or hygienic " Fiery Cross ".

The success that attends fortune-telling, crystal-gazing, the revelations of the fashion-

able palmist, the predictions of gipsies, and other itinerant irresponsibilities, is wholly due to the strong vein of childishness that runs through the mental constitution of even the most mature of us. What is "Moore's Almanac" in its astrological aspect but an annual appeal to childishness? For it is supremely childish to-day to continue to believe in the influences of the stars, in having one's horoscope "cast", in lucky and unlucky conjunctions of the planets on one's birthday, in the baleful influence of comets and the sort of thing that was honestly believed when astrology had not as yet given place to astronomy, nor alchemy to chemistry. There was a day—about 700 years ago—when the first intellects of Europe believed that the heavenly bodies did really influence human destiny, when "ill-starred" did actually refer to the stars, when "the music of the spheres" and "the stars in their courses" were axioms in physics, but *nous avons changé tout ça*, or think we have.

Much of that sort of thing lives on in many minds as a phase of racial childishness in virtue of the potency of racial, psychic momentum. In some quarters we do not

seem to have passed mentally beyond the conditions described by Dr Fielding H. Garrison in his " History of Medicine," when he writes of " these popular almanacs . . . (which) show the hold which judicial astrology has taken upon the people. In some of them a special figure, the ' Zodiacman ', indicates, as in drug-store almanacs of more recent date, the part of the body influenced by the different planetary conjunctions, the proper times and places for bleeding and purgation under each sign of the Zodiac, with gloomy prognostications of the terrible diseases, wars, famines, and other pests which were to befall humanity under different ascendencies and conjunctions of the planets. Palmistry also attracted wide attention ".

One expression of childishness in adult life which may actually be a serious menace to the welfare of the community is the activities of the anti-vaccinators. This particular form of childishness is that these people are unable to appreciate the import of the historical and statistical evidence in favour of vaccination against smallpox. The anti-vaccinators do not believe that the question whether there shall or shall not be

universal vaccination is one for the medical expert, and not for the layman at all. These anti-vaccinating members of the laity are impervious to evidence, and are constantly making mistakes about cause and effect. They are the present-day representatives of that class of person who throughout the ages has opposed everything new. Edward Jenner was by no means the only promulgator of a discovery who suffered opposition and misrepresentation, for Galileo, Harvey, Simpson, Semmelweiss and Lister were all, at first at least, ridiculed, thwarted, and opposed. This form of childishness, as an expression of social psychological inertia, may be a very serious thing for the public health. Possibly some of the leaders of anti-vaccination are ineducable, which is an expression of physiological inertia.

Childishness in adult life occasionally expresses itself in morbid emotionalism, as when a whole community signs a petition to reprieve a murderer. This unreasoning and irresponsible adult childishness overlooks the fact that legal experts have considered all the aspects of the case and deliberately come to the conclusion that the prisoner is guilty of murder, and that, as the law stands,

the death-sentence must be carried out. But just as the child who happens to want something very much totally ignores your explanations of why he cannot have it, so a community in virtue of its childishness will brush aside the whole logical chain of reasons whereby the criminal was convicted, and simply cry out that the sentence must be commuted.

Many people never grow up. The childishness of the present-day adult may be concealed or repressed by the conventions of society, but it quickly rises to the surface when any great crisis is being passed through or momentous event witnessed. The extravagances known as " mafficking " are the violent uprushing through the veneer of civilization of the latent childishness deep in the emotional nature of ninety-nine per cent. of us. Just as the haschisch-poisoned oriental " runs amok " in his murderous career, so the educated adult of to-day returns on occasions at one leap to the irrepressible violence and buffoonery of his irresponsible childhood. The Armistice was the occasion for the ebullition of emotional infantilism on a scale hitherto unknown. Grave and reverend seniors joined in the commotion ; respectable

people danced on restaurant tables and deliberately threw the crockery about the room.

Delight in the creation of sheer noise is not confined to the half-intoxicated "bean-feasters" of Whitechapel on Derby Day; at times it can overcome the so-called educated classes. The following is the description of bringing in the New Year (1925) in New York [1]—

"The crowds on Broadway at midnight were colossal, and the noise was indescribable. The hubbub was augmented by a radio which transmitted the noise made in other towns. 'Liquor-drunk and money-drunk,' is the phrase used by the *New York Tribune*. Vendors of cow-bells, horns, and other noise-making instruments did a roaring trade at prices double those of last year."

Some critics would call this vulgarity; but healthy children love noise, and the nursery is its place: here we have an atavistic return to the nursery or to the monkey-tree on a very large scale. Those who thus saw the New Year in were still acting as children; when they became men they had not put away "childish things".

Just as under the placid surface of con-

[1] cf. *Daily Mail*, January 2nd, 1925.

ventional morality and respectability the psycho-analyst tells us there are vast submerged complexes of immoral and criminal tendencies, so under the educated, civilized exterior of the adult man and woman of to-day there is a great substratum of pure childishness. "Scratch the Russian and you find a Tartar"; but it does not require very much emotional scarification of the adult to reveal the unchanged child within. Just as the Great War undoubtedly brought to the surface much of the self-denial, heroism and hardihood fortunately still latent in many men and women, so certain times of peculiar stress may reveal the not very deeply hidden childishness that lurks in the mental make-up of most of us.

III

WHO SAID THAT FIRST?

THE ORIGINS OF SOME FAMILIAR WORDS AND NAMES

The origins of words and names are interesting, even if we are not particularly interested in the things to which the words refer. And the man who first used a word so apt for his purpose that it remained for ever afterwards in use in a language cannot fail to be worthy of notice.

It is also satisfactory to know, if possible, the exact date in the history of a science when a new term was introduced. For instance, the every-day word "electricity" was made up by William Gilbert, a physician and naturalist, about 1600. He derived the term from the Greek word for "amber". Or, again, how few of us know that the term "energy" in the modern sense of "capacity for doing work" was introduced

as recently as 1807 by the great mathematical physicist, Thomas Young, M.D.

GAS AND BLAS

Let us begin with the word "gas", a word as widely used as any small word in English. It is a word without any derivation at all, it has no "root", it came from nothing other than the brain of a Belgian chemist, Jean Baptiste van Helmont, about 1630. He needed a word to express the invisible volatile substances which were neither solids nor liquids that he constantly encountered in his chemical investigations. There was no pre-existing word to designate such substances, and so van Helmont coined the word "gas"—a word without descent—a veritable etymological Melchisedek.

As a matter of fact, he coined two words at the same time—"gas" and "blas". Blas was his term for the other invisible principle, the principle of life; but whereas to-day we could give van Helmont (if he returned to earth) many litres of many kinds of gases, we could not materialize for him the smallest quantity of blas, for gas once the concept

is now a substance, but blas the concept is the concept still.

Speaking of gases, oxygen is the one with which we are most familiar ; we can carry it about compressed in cylinders, take it under the ocean or soar with it into the clouds. But it, too, was once just a concept in the mind of the great French chemist, Lavoisier, who about 1772 called it "oxy" "gine" or "the producer of acid" from a rather mistaken conception of its properties.

Our own Priestley was the first person to isolate the gas, but he named it still more unsatisfactorily "dephlogisticated air", after Stahl the German's erroneous theory of matter and heat.

THE MIGHTY ATOM

The atmosphere is a mixture of gases, and these exert pressure. The word "barometer" was coined by the English chemist, Boyle, to describe the instrument which measures the pressure of the atmosphere. It is from the two Greek words for pressure and measure.

The Honourable Robert Boyle, the fourteenth son of the first Earl of Cork, was one

of England's earliest and most distinguished men of science. He devoted his whole life to research, much of which he did in Oxford. He discovered the law known as "Boyle's law", which relates the pressure and the volume of gases.

We cannot think of gases, liquids or solids without thinking of the atoms of which they are composed. Who first said "atom", which merely means in Greek "not cut"? Only a very profound student of Greek philosophy could answer that question, and even he might not be able to say more than that the word was used as long ago as about 460 B.C. by a Greek known as Democritus of Abdera, a town in Thrace. But it was the Englishman, the Quaker, John Dalton, who, about 1803, gave to the atom its modern meaning as the smallest conceivable portion of matter able to enter into chemical union with some other portion. The atom was conceived to be the ultimate portion of matter until the notion of the modern electrical constitution of matter was arrived at.

The "molecule" (from the Latin for a small mass) is the smallest portion of matter that can exist in the free state—quite a different thing. A molecule may be made

up of many atoms. The word was coined about 1811 by an Italian professor of physics at Turin, Amadeo Avogadro.

We might now leave the non-living world and go over into that of life. Who first said "Biology", a word in quite common use to-day? It was a German naturalist and physician, G. R. Treviranus, at Bremen, who made up this word for the science of the study of life in general, which is what we mean by biology. It comes from the two Greek words, a discourse about life. Treviranus coined it about the year 1805 as the title of a book he wrote dealing with living things—"Biology, or the Philosophy of Living Nature".

PROTOPLASM

We cannot think nowadays of living things without thinking of the name for the living substance itself, protoplasm, or "the physical basis of life", as Huxley called it in his famous definition. The word protoplasm, which is the Greek for the "first formed thing", was first used by a Bohemian physiologist, J. E. Purkinje, in the year 1839 to describe the living substance composing animal embryos as in the egg, material not as yet even

differentiated into the embryo. Soon biologists began to use "protoplasm" to describe living substance wherever found, whether in plant or animal, in the embryo, in the young or in the old.

No less a man than Goethe himself coined the word "morphology", which is the proper term for the science of the study of the form or structure of an animal. "Anatomy" is the more familiar term, but anatomy means merely a cutting up. As a term, "anatomy" has no reference to the structures laid bare by the cutting up, whereas morphology means precisely a discourse about forms.

From visible forms we may pass to invisible, and at once think of "microbe". This is rather an interesting word, because, as it stands, it means in Greek a short life rather than a small living thing. It is, however, always in the latter sense that it is used, and in this sense it was coined by a friend of Pasteur, the French surgeon, Charles Sedillot, in 1878. The allied term "bacterium", now in such general use for one of the species of microbes, was first employed in its present meaning in 1865 by the well-known French physician, Dr Casimir Davaine, the discoverer of the germ of anthrax.

HUXLEY'S TWO NEW WORDS

The very useful word "anæsthetic" was coined by the American physician and poet Oliver Wendell Holmes in 1846, to designate a substance which abolished sensation or feeling, for it comes directly from the Greek for "not feeling".

We may close this short study of first things by reminding ourselves that the word "agnostic" was coined by Professor Huxley so recently as in 1869. Many people suppose it to be of much greater age. Huxley devised the word to describe a person who did not possess the positive knowledge or certainty about a vast number of subjects of which most people seemed so sure. Huxley on becoming a member of a debating society called the "Metaphysical", found that he was not prepared to "label" himself as belonging to any recognized sect or body. He was not an "ist" of any kind, "so", as he says himself, "I took thought and invented what I conceived to be the appropriate term of 'agnostic'."

"It came into my head as suggestively antithetic to the 'gnostic' of church history

who professed to know so much about the very things of which I was ignorant. To my great surprise the term took . . . the 'Spectator' stood godfather to it."

The term did indeed "take", and in a sense which its inventor never intended, for instead of being used in his original and negative sense to describe an attitude of ignorance and uncertainty regarding anything about which we have no positive information, it came to be employed carelessly as the equivalent of "atheist" and "infidel".

This was entirely unwarranted and exactly the opposite of Huxley's meaning, namely, the absence of exact knowledge or certainty. As his son and biographer says, he enriched the language by two new words; but it would be hard to find any two which have been so perverted from their original signification as "agnostic" and "agnosticism".

IV

MYTHOLOGY AND SCIENCE

THE GODS OF DRUGS

Mythology has been drawn upon to supply scientific names and terms more often than one would suppose. For instance, ammonia is named after the Egyptian God Ammon —the Jupiter of the Egyptians—whose temple in the desert was nine days' journey from Alexandria. It had a celebrated oracle which Alexander the Great is said to have consulted. The alkali, ammonia, is believed to have been first prepared from the dung of camels tethered round the temple. Of course we are quite familiar with mythological proper names in chemistry, having to go no farther to find one than the metal Mercury.

Mercury or Quicksilver in a pure state is a liquid, and when spilt at once assumes the spherical form, in which condition the drops roll about with great ease and speed

and are particularly difficult to collect again. No doubt this characteristic of power of very active movement was the reason of the liquid metal being called by the name of the Messenger of the Gods, Mercurius. Besides being the messenger of the gods, Mercury was the god of music and commerce, of prudence, cunning, fraud and theft. As employed by the gods to conduct souls to the nether regions, he would, in the nature of things, be kept very busy. Many of the metals had divinities attached to them, as for instance Sol, the sun, to gold; Argentum the moon, to silver, and Luna, also, to silver as in the expression "lunar caustic" (silver nitrate). Saturn was attached to lead, which explains why poisoning with lead salts is called "saturnism", though "plumbism" is a commoner term. Saturn was an early Roman god, the son of Uranus (heaven) and Gæa (the earth), and the father, no less, of Jupiter and Neptune.

Probably not many of us remember when we speak of "morphia", that we are referring to Morpheus, the god of dreams, the word being derived from Morphe, the Greek for form, because of the forms of things seen in dreams. From this same morphe we get

the scientific word morphology, the study of the forms of plants and animals, the more correct word for "Anatomy", which, as we have seen, means "to cut up". It is a fact that the sleep induced by morphia is apt to be very dreamy. Morphia is the active substance of laudanum, the tincture of opium. It is well known that opium eaters sometimes experience the most gorgeous visions, as were described by de Quincey in his "Confessions of an Opium-Eater".

Another very powerful medicinal substance, atropine, takes us back to an interesting myth. Atropos was the most terrible of three Fates—the one who cut the web of life spun by the first Fate.

Atropine or atropia is the poisonous essence in Belladonna, the deadly Nightshade. In minute doses it is a valuable drug, in larger doses it is a deadly poison. Thus it was named Atropos after the most relentless of the three Fates—for Atropos means in Greek, never turning or bending, the inflexible one. It is the same word as gives us heliotrope, the flower that turns to the sun. Indeed, our word trope, a clever turning of a phrase, comes from the same root. But does not the word "lethal" take us back to Lethe,

the river of death, a river in the infernal regions, to drink of whose waters induced forgetfulness of the past?

The Zoologists have always drawn largely upon classical mythology for the names of animals, and some of their allusions are very apt. For instance, there is an Australian animal, the porcupine ant-eater, which, although it is a mammal, lays eggs. In reference to its half-and-half nature, it has been named Echidna, for in mythology this was a monster, half-woman and half-serpent.

HERMAPHRODITE

Very naturally, Echidna was the mother of monsters, one of which was Chimæra. A very ugly cartilaginous fish has been named Chimæra monstrosa. The chimæra of the Greek myth had a lion's head, a serpent's tail and a goat's body, which curious mixture was female. We might have expected the spider to be called by Zoologists arachne, because Arachne was a maiden who so excelled in the art of weaving that she challenged Minerva to a trial of skill. Being defeated, she hanged herself and was changed by Minerva into a spider.

What could be more appropriate than calling an animal in whose body the organs of both sexes were united "hermaphrodite"—the being compounded of male and female—Hermes and Aphrodite, or, more familiarly, Mercury and Venus? It is a much more picturesque term than "bi-sexual".

This turning to classical mythology is by no means only the practice of a past day. Modern Psychological Medicine is full of it, as for instance, the term "Narcissism" which means a morbidly intense love of oneself, derived of course from the myth. Narcissus was a handsome youth, but insensible to the emotion of love; the nymph, Echo, fell in love with him, but her love not being returned, she pined away in grief. In order to punish Narcissus, Nemesis made him fall in love with his own reflection in a fountain, whereupon he became so enamoured of it that he gradually faded away and was changed into the flower that bears his name.

V

SCIENCE AND CHARACTER-BUILDING

Most people, if asked to say what went to the building up of character, would probably reply somewhat as follows: Religious instruction, education and early example; in other words, one's early environment; and they ought to add, one's hereditary dispositions. Our concern is Science and Character-Building. Of course, it is obvious that the pursuit of science gives a mental training second to no other intellectual exercise, for science is against a mental haziness and mental laziness. Superstitions fly before it, and fallacies and non-sequiturs are excluded, Science tells us, for instance, that we cannot get something for or out of nothing; no heat without food; that no work can be done without drawing upon a source of energy. It clears the atmosphere and widens the mental outlook.

Now, character is something more than being conventionally moral, for weak people can be moral ; and some quite conventionally immoral people have been strong characters, as, for instance, Cæsar, Nelson and Napoleon, not to speak of King David. Character meets and defeats the temptation rather than avoiding it in a cell, which is monasticism. Morality, that is true ethics, recognizes the claims of others, but character does this and more ; it influences, stimulates and directs other people as well. Character is the substance of the mirror, reputation is the reflection from it seen by other people.

Character is strong without being oppressive, just without being narrow, self-reliant without being self-centred, having fortitude without obstinacy, being broad without being complacent towards low ideals, being tender without being weak—in a word, " hating the sin, but loving the sinner ". As Chaucer put it, " being a most perfect gentle knight ".

Now, what do we mean by Science? I mean by Science that training of the mind imparted by a rigorous, unbiassed and sympathetic study of nature. Towards character-building Science in the first place teaches us patience, care and exactness. Patience

over the difficulties and obstacles which abound in our wresting from Nature her elusive secrets, for Science tells us that we must not expect results easily and without effort; and it is not a simple matter to question her aright. Science teaches us care in planning our experiments so as to avoid pitfalls. We are taught care in interpreting results, in distinguishing between facts and inferences, in eliminating the accidental from the essential. Science gives us courage to overcome difficulties, and it rewards us by allowing us sometimes to think the very thoughts of God.

Science teaches us dignity in all things, that nothing is "common or unclean", that everything in its own place is good and that "every creature of God is good and nothing to be despised". It shows us everything to be full of interest and how everything may be ennobled; it tells us that nothing is insignificant or worthless. To it, the weed is but a humbler flower, the flower a fairer weed. In Science nothing is trivial, everything has at least a potential import. There is, for instance, no such thing in surgery as a trivial wound; the most trivial wound has sometimes led to blood poisoning and death.

I venture to think, for instance, that it is such men of science as have been sent to the House of Lords that have conferred dignity upon that chamber. The presence of men of exact knowledge like Lord Kelvin and Lord Lister in such an assembly could not fail but to contribute to its dignity and efficiency. Science to that extent has given it its character.

Science produces heroism in her workers, who labour often alone, unfriended, abused, misrepresented and misunderstood. To whom do we owe the emancipation of the body and mind from the thraldom of ignorance? To the heroic men of science. To whom freedom from pestilence? To the heroic microscopist. He is not the only kind of hero who wades through blood to a coronet; he is the hero who in the silent hour after hour works at the laboratory bench, his name on no man's tongue, no nation's thanks or parliamentary votes awaiting him, who works in close quarters with death while the pestilence rages all round about him.

And has Science not had her martyrs? What about Roger Bacon, was he not worried? What about Copernicus, was he not worried, no less a man than Luther calling him a

fool? And what about Bruno, who was burned alive; and Galileo, who was imprisoned for the last third of his life; and van Helmont, who had heresy attributed to him; and Vesalius, who was very effectively worried? And what about Tagliacozzi of Bologna, whose bones were scattered by the order of the Church? And what about Priestley, whose house and papers were destroyed? And what about Harvey, who found all his professional brethren against him, and whose papers were burned? And Jenner, who was worried and obstructed all his life; and Lavoisier, who was executed in the middle of his researches; and Simpson, who was violently railed at; and Lister, who was stupidly ridiculed? And there have been many others in the noble army of the misunderstood and persecuted, some of whom have been martyrs in the active sense. Did not John Hunter inoculate himself with a loathsome disease in order to study its clinical manifestations? Did not Simpson experiment with chloroform upon himself, and Sir Patrick Manson's son inoculate himself with malaria?

And yet Science also gives us humility. How could it be otherwise when we get a

sense of the vastness, the detail and the intricacy of Nature? We must stand amazed. Consider the scale on which Nature works, consider the majesty of the cosmos, the magnitude of the divisions of time and space on the one hand (think of "light-years", which is the measure of the time that light takes to reach us from the most distant stars), and the minuteness of the divisions of time and space on the other, when we are dealing with billions of vibrations of light per second—the stupendous vastness of the one, the inconceivable smallness of the other. Truly, we can but stand amazed, and say in all humility—

"When I consider Thy heavens, the work of Thy fingers,
The moon and the stars which Thou hast ordained;
What is man that Thou art mindful of him,
Or the son of man that Thou visitest him?"

Science teaches us respect; respect for Nature, for her grandeur, her everlastingness, the inexorable uniformity of her procedures, the inevitableness of the recurrence of her cosmic rhythms. Science, I say, teaches us reverence for facts, for truths, for truth. If "the undevout philosopher is mad", the irreverent man of science is out of harmony with the highest and best. And do you ask

what is truth? Truth is what men of character search for, reverence and seek to declare. Science in particular teaches us reverence for life. I take reverence for life as the touchstone of character. Neither the science without morality of the Germans nor the science-bereft immorality of the Bolshevik has any reverence for life. Now, the following very great men of science were reverent, and they were all minds of the first order—will you bear the repetition of their names?—Pascal, Descartes, Paré, Harvey, Hales, Priestley, Dalton, Faraday, Pasteur, Lord Kelvin, Sir Gabriel Stokes, Sir James Simpson, Lord Lister and Sylvanus P. Thomson. Doubtless we could name an equal number of men equally eminent and equally reverent in literature, philosophy or art. But science is supposed to be irreverent.

And Science gives us sympathy. The man of science who knows the heights and depths of nature, and especially of human nature, cannot but have sympathy, for sympathy is intelligent insight, it is imaginative comprehension. Thus it comes about that children, people of feeble intellect, idiots and animals are what we call cruel in that they have not the knowledge necessary to

give them that sympathetic imagination. Men of science, especially physiologists, are supposed to be particularly lacking in sympathy. May I relate how one physiologist died? My friend, the late Dr Page-May, an eminent physiologist, was walking along the street in Brighton when he noticed a carter ill-treating a lame horse. He reproved the man, who replied in the unrepentant blasphemy of his kind. Dr May's righteous anger was so roused that he went over to give him a little of the same treatment that he was giving the horse, when the doctor burst a blood-vessel in the brain and died within a few minutes. He was not only sympathetic, but he could express righteous anger. I venture to say that one of the most horrible crimes committed in the Great War was the making of the dumb animals, the horses, suffer. "Man's inhumanity to man makes countless thousands mourn", but it never should have included the lower animals.

Science teaches us respect, respect for other people's opinions, rights, beliefs, doubts, prejudices, tastes and foibles. It teaches us that we are what we are by reason of hereditary disposition and constitution and owing

to the atmosphere of an early environment. It tells us that that child is stupid because it is anæmic or tubercular or has adenoids or a brain centre congenitally undeveloped. It tells us that a man's temper is the result of disease latent or actual in his nervous system. It tells us that a woman's behaviour is due to neurasthenia.

It teaches us a new criminology. It recognizes in the parental germ-cells physical factors for the various inherited features and qualities. Hence, it declares that so much of us is pre-determined, if not pre-destined. It explains a very great deal of the puzzles of behaviour by recognizing the double and even the triple personality. For indeed, personality "A" may be your amiable friend; personality "B" may be that extremely disagreeable person who is, however, one and the same. It tells us, in fact, that all men are not equal, not equal physically or mentally, neither in constitution, disposition, capabilities, endurance, nor in powers of resisting temptation. If there is one fact more obvious than another which has been made evident in recent sociology it is that all men are not equal. We are assured that much crime is due to

enfeebled mentality, and therefore it is " weakness to be wrath with weakness ". But surely we can have sympathy with weakness and be ready to admit that " to know all is to forgive all ", not in the indifference of latitudinarianism but in the fervour of an intelligent, scientific comprehension.

And Science teaches us restraint, though it calls it by the arid term inhibition. Here, at least, Paganism, Christianity and Science are agreed and can all meet on common ground. Pagan philosophy always counselled moderation ; Christianity said " Let all things be done decently and in order " ; Science teaches us the extreme importance of avoiding extremes, of restraining tendencies to overaction. Science has actually discovered nerves for that very purpose. It, therefore, may well preach restraint, and when it says restraint it means restraint all round, in matters of food, drink, sex, exercise, rest, money and power. It agrees with Shakespeare that " It is excellent to have a giant's strength, but it is tyrannous to use it as a giant ". Monasticism fled from the world in total abstinence. Science meets the temptation by restraining the tendency to succumb. Inhibition was preached long ago by the

Hebrew poet, but in words far more beautiful than those of modern science, "He that hath no rule over his own spirit is like a city that is broken down and without walls; but he that ruleth his own spirit is better than he that taketh a city".

And, lastly, Science reveals to us beauty; just as religion teaches us the beauty of holiness, so Science teaches us the beauty of Nature, intellectual beauty in the exactness of the fulfilment of a prediction, an eclipse for instance, occurring, or a comet returning to the fraction of a second as predicted. Science sees beauty in the majesty of that law whereby the planets are rolled through the corridors of heaven. It sees beauty in the recesses of the infinitely little, beauty in the adaptation of means to ends in living bodies, beauty in the simplicity of the means whereby these ends are attained. It reveals marvels of mechanism which man has but discovered, which have been in operation in animal bodies for æons and æons of time —pulleys, levers, valves, lubricated surfaces, lenses, sensitive plates, iris diaphragms, solid tissues as transparent as glass, electric currents and the utilization of negative pressure, all were in existence ages before man himself appeared.

The goal of the highest science is the comprehension of the true and the beautiful as only two different aspects of that supreme knowable, the intelligible cosmos.

Great is Science, and it will prevail. Let us not listen to people who tell us that Science destroys poetry, the æsthetic sense, reverence or religion. The day of the materialistic, unpoetical, unlovely omniscient scientist is gone, we hope, forever. The poetical man of science is certainly a possibility; he has come and seen and conquered the absurd notion that the poetical outlook is incompatible with the scientific. "Proud philosophy" and "cold science" belong to the eighteenth, not to the twentieth century.

The tints of the rainbow are not less but more beautiful to the physicist because he knows how they come to be there, and why in that particular order. Keats' lament that Newton, by explaining the rainbow, had taken the poetry out of it, means merely that Newton had taken the poetry out of the rainbow for Keats.

The lily-of-the-valley will smell quite as sweet to me even though I may live to see the day when its odour-producing substance

has been identified, extracted and named by the chemist. The man of science can be as sensitive as the veriest artist in presence of the beauty of colouring or of outline, even although he is able to explain the source or origin of them both. The man of science is not the less sensitive to physical beauty which appeals to the senses because he happens also to know of another order of beauty which appeals to the intellect.

It is some time since true men of science jeered at religion. For to some of them, what is called "religion" is but one more phenomenon they are called upon to explain. The complete man of science is not only a poet, he is a reverent poet. The prayer of the lisping child, no less than the profoundest abstraction of the philosopher, is worthy of his study.

Why is life so vapid for so many? Because they know neither facts nor the explanations of facts. They know not the wonder, the beauty, the richness or the variety of Nature's treasures. Culture is too often thought of as a state of mind which is the outcome of a knowledge of some of the expressions of Art; it is very rarely imagined as due to the possession of the scientific temperament.

But culture is really not so much the result of the possession of knowledge as an attitude of mind or disposition, a sympathetic attitude of mind towards all mental products and intellectual interests.

The study of science is in many cases able to confer a truer culture than half a lifetime spent in studios or around pianos. Your painter or musician may be a perfect barbarian, ignorant, superstitious, self-satisfied and intolerant. There need be no fear of allowing science to be freely taught. Not science, but a hideous, preposterous, soul-destroying ethic it was that made possible the barbarities of the Great War. Science without a love of the beautiful, without respect for the past, without poetry, without sympathy, without reverence, is the most repulsive product of the mind of man. But such, truly, is science falsely so-called.

Science, the true, is the patient, loving interpretation of the world we live in. It is striving to attain not merely to an understanding of the laws whereby the world is governed, but to the enjoyment of the beauty and order which is everywhere revealed. And the minds of men capable of attaining to such heights of appreciation, and the evidences

around us of all-pervading personality, are only so many additional phenomena to be apprehended as constituent elements of that vast, sublime, age-enduring cosmos which we call the Universe.

VI

FROM THOUGHTS TO THINGS

The whole tendency in science is to pass from the vague to the concrete. The History of Science has several examples of an idea becoming realized, of a prediction coming true, of a metaphor becoming a fact. One meets with a thing first as a " principle ", a potentiality, a conception in some investigator's mind, and one ends with it as a species of matter tangible, visible, ponderable ; the notion has been materialized, the hypothetical thing embodied.

The discovery of " new " chemical elements for which a place has been reserved in the " periodic series " is the sort of thing of which we are thinking. The chemical elements of a natural group are arranged in a linear series according to their atomic weights and other properties ; and one finds that in such a series there are numbers of gaps, places where no *known* elements fit in.

But from time to time an element possessing the properties of the hitherto unrecognized one is discovered, and at once placed in its niche. Helium is such an element. At one time its niche was empty; chemists said there *should* be such an element, just four times as heavy as hydrogen, for which there was a place in the series. For long, there was "a hypothetical element with an atomic weight of four".

In due time the late Lord Rayleigh and the late Professor Ramsay by means of the spectroscope found evidence of such an element previously suspected in the sun, and therefore named Helium.

As yet it had no recognized terrestrial habitation though it had a name. Later, Ramsay found it in various places; in the waters of certain hot springs, for instance; and it was soon isolated and found to be an inert, non-inflammable gas. Before long it was produced in bulk; to-day millions of litres of it are used to fill dirigible balloons, in which it is vastly preferable to the dangerous explosive hydrogen.

The hypothetical substance of the depths of the chemist's brain has been exteriorized into the material gas.

The discovery of another gas, oxygen itself, illustrates very well this tendency towards the definite.

The father of chemistry in France, Lavoisier, was studying a "principle of acids", or "acidifying principle", of which he wrote in 1777: "I shall therefore designate dephlogisticated air, air eminently respirable, when in a state of combination or fixedness by the name "acidifying principle", or if one prefers the same meaning in a Greek dress, by that of "oxygine principle".

Here we see the process at work; the "thing"—etymologically that which is thought—arises in the mind as an "acidifying principle", which is Latin; if we wish this in Greek it is "oxygine"; before long it is isolated and identified as the invisible gas, oxygen, whereby we live and move and have our being.

This process towards the concrete is far reaching; for though it took 120 years to accomplish it, by 1897 the invisible gas was actually liquefied, and we could see in the steel-blue liquid, oxygen, the very materialization of a concept; the word had been made substance.

And the reward of its discoverer?—the

guillotine! So much sympathy has the mob with intellectual achievement!

In the familiar word "gas" itself we have another example of the evolution from the vague to the concrete. The word "gas" was the very coinage of the brain of the Belgian chemist van Helmont, who devised at the same time the corresponding term "blas". How he came to invent them let him explain in his own words. He says they are "two new terms introduced by me because a knowledge of them" (that is of the things which they indicate) "was hidden from the ancients". He appears to have thought that the sound of the word "gas" resembled that of "chaos", the name for the universal, unformed condition of primal existence.

Now whereas the concept behind the word "gas" has become an indispensable part of chemistry, "blas" has remained an arbitrary name for a hypothetical and completely unknown existence called "spirit". As a matter of fact the word has never been used at all.

The terms "positive" and "negative" electricity began as suppositions made by the early naturalists; they were arbitrary

terms, a sort of guess to describe the behaviour of a force which in any other way it was very difficult to visualize. For long these terms remained merely suppositions; but now the physicists tell us that positively and negatively charged particles are real existences. Sir Oliver Lodge writes in his "Ether and Reality" (1925): "The two oppositely charged particles, the negative and the positive, are called (respectively) an electron and a proton. . . . Different atoms are known to be composed of different numbers of electrons. . . . The atoms of all the chemical elements are built up of electrons and protons and of nothing else".

A very similar story may be told of the atom and the molecule. The atom as Dalton conceived it in 1804 was the smallest portion of matter which could enter into chemical combination. In course of time the Italian chemist, Count Amedeo Avogadro (1776-1856), became convinced that there must be bodies composed of two, three, or more atoms, compound atoms in fact, which could exist in a state of freedom. Avogadro therefore coined the word molecule (diminutive of moles, a mass) in 1811 "as a term of convenience", to express his idea of the

smallest portion of matter able to exist in a free state.

For many a day Avogadro's molecule was still "a term of convenience"; but to-day the molecules have been weighed and measured. "The Brownian movement," says a recent writer, "has revealed to us bodies intermediate between ordinary particles and single molecules, and has enabled us to estimate the actual weight of molecules. . . . There is thus no question that molecules and atoms are real." Hence the thing that began its existence in the world of the mind has attained to a reality independent of the mind altogether; the conception has as its counterpart an object in the environment.

Modern Biology furnishes us with several examples of progress from the vague to the concrete, for instance the case of the ferments. At one time digestion was confused not only with putrefaction, but with boiling and with the effervescence of gas in chemical operations.

The very notion of a ferment, a substance not itself living but produced by living matter, had not emerged from the mental confusion in which such experimenters and thinkers as van Helmont, Sylvius, de Graaf, and Haller were enmeshed.

The Frenchman Reaumur was the first to obtain gastric juice in an approximately pure state, and to cause it to perform digestion outside the body. The Italian, Spallanzani, working at Pavia in 1777, discovered that digestion in the stomach was the exact opposite of putrefaction, and was in fact due to some " solvent power " or " active principle of solution " in the gastric juice.

In 1862 the " principle of solution " was isolated as a whitish powder, the ferment " pepsin " so named by Schwann in 1836.

Soon other ferments were isolated; and to-day in our laboratories we store in glass bottles dozens of these substances called enzymes, the modern representatives of the principles of solution of former times. The notion has been materialized, purified, and dried.

Our next example of physiological definiteness may be that of the Internal Secretions. For thousands of years nothing was known or even guessed about the function of the two inconspicuous bodies, the supra-renal capsules or adrenals, ductless glands, found quite close to the kidneys.

In 1855 Dr Thomas Addison of Guy's Hospital, London, described a disease, since

named after him, in which the patient suffered from an extreme degree of weakness in the heart and body muscles, and after death was found to have had his supra-renal glands degenerated, usually owing to tubercular infection.

It was very naturally assumed that in health the supra-renals produced something which, entering the blood, was carried to all parts of the body to maintain the tone of the muscle of the heart, and of the blood-vessels as well as of the body muscles. This "something" was apparently absent in Addison's disease.

This "something" remained undiscovered until 1895 when, on a watery extract of the supra-renal being injected into an animal's vein, the blood-pressure rose to an astonishing height through the muscle of the heart and of the blood-vessels having been vigorously stimulated.

Something contained in the watery extract of the supra-renal evidently possessed powerful physiological effects; it may be named "adrenalin", although as yet it is a hypothetical secretion.

After some years of research between 1897 and 1904, the biochemists succeeded

in separating from the glands a substance which in solution possessed all the properties of the extract of the supra-renals. It is widely used to control local bleeding. Soon adrenalin was made synthetically; and at the present time not nearly all the adrenalin used in medicine is derived from the actual gland. Within fifty years of the suspected existence of an internal secretion of the supra-renals, the natural substance was isolated, the "structural" formula ascertained, and the synthetic substance manufactured on a large scale.

Here we have the crystallization of a notion; the thing of the mind has become a thing of the laboratory; the thought has been captured.

This is not the only member of the group of internal secretions or hormons which has been isolated and identified.

In 1914 the American biochemist, Dr Kendall, isolated from the thyroid gland its active principle and named it thyroxin. Still more lately thyroxin has been synthesized. Thyroxin produces the same physiological and therapeutical effects as does administration of thyroid extract or grafting of the thyroid gland.

For thousands of years the thyroid and other ductless glands were an enigma ; within the last thirty years physiological chemists have been enabled to extract and bottle the active " principles " of at least four ductless glands, the supra-renal, the thyroid, the pituitary, and the pancreas. This last, called " insulin ", discovered so lately as in 1922, is the hormon which enables the body to deal properly with its absorbed sugar, and in the absence of which the serious disease diabetes results. Within the last few years the lives of thousands of persons have been saved by the injection of this anti-diabetic " principle ". These " principles " are now sold over the counter.

The physiology of Fatigue supplies us with another instance of the progression of ideas from indefiniteness to definiteness.

Fatigue is an ill-defined and not altogether disagreeable state of our consciousness ; but quite evidently it is also a bodily condition. There is a slight soreness about joints and muscles, a tending to drag the legs, a limpness everywhere, a tendency for the eyelids to droop and the head to fall forwards. All these things are an expression of its physical basis. Fatigue has been found to have a

physical basis in the nervous system like so many other and more definite species of consciousness. If nerve-cells be prepared appropriately for microscopical scrutiny, it is noticed that in all healthy cells there are numbers of short, rod-like bodies which take on a bright blue stain devised by a German neurologist, Professor Nissl of Heidelberg. These minute prisms are therefore called " the granules of Nissl ".

When one examines cells that are diseased, as for instance, in epilepsy, mania, alcoholism, we can see that these granules are no longer clearly defined, but are blurred on their edges, and, as it were, partially dissolved away. The biologist's word for this is chromatolysis.

Now the interesting thing is that if we examine the cells in the nervous system of a very fatigued animal, we shall find well-marked chromatolysis.

The nerve-cells innervating the wing muscles of a sparrow, before it had begun to fly about for the day, were scrutinized and taken as normal ; then similar cells were examined in a bird killed after it had been flying about all day, and these two sets were compared.

The cells from the tired bird were found

to have their granules noticeably blurred in outline.

Finally, if a fatigued bird was allowed to rest and then killed, and its nerve cells were examined, they were found to show no signs of blurring of the granules. It is clear that they had recovered. Fatigue, then, has a physical (microscopical) basis; in other words, so elusive a thing as tiredness has been proved to be related to most definite minute structures in the remotest depths of the nerve-cells.

But this discovery only leads to another inquiry—What is it that induces this wearing away of the granules of tissue in fatigue? The answer is that fatigue on its chemical side is due to certain substances circulating in the blood which bring about a condition of mild intoxication of the nervous system. Nothing is more familiar than that fatigue leads to sleepiness, and this type of sleep is almost certainly a mild chemical poisoning. The biochemists have not as yet fully identified these fatigue-producing substances, but there can be no doubt whatever that such exist and that they are responsible for the microscopic changes seen in nerve cells in fatigue. Thus has physiology objectified the subjective.

No topic of general interest seemed at one time so hopelessly vague as that of Heredity.

Where does the offspring originate? Why does it resemble its parents and yet differ from them? How can it resemble more distant ancestors? How are family traits and peculiarities preserved from one generation to another? Those and other allied questions have been asked by everyone some time in their lives.

Before the microscope revealed the invisible female ovum and the invisible male sperm, all ideas about the mechanism of descent were in a state of chaos. It was quite impossible to know whence the embryo came when its beginnings were far beyond the realm of human vision.

Of course, not all eggs are microscopic; those of birds, fishes, and reptiles are not; but those of mammals are, and hence it was that the earliest stages of the mammalian embryo were such a mystery.

The mammalian ovum was not seen until 1827, when the Russian embryologist, von Baer, removed one from a living rabbit. Human sperms had been seen under the microscope for the first time so long before

as in 1677 by the Dutchman, Leeuwenhoek, at Delft.

Before the discovery of the male element, the wildest notions were held as to the influence of the male parent. Our own Harvey, the sagacious and very able discoverer of the circulation of the blood, could not see his way out of the maze. The undoubted power of development of certain insects' eggs without male aid (parthenogenesis) was a fact that merely increased the confusion.

As an example of how much astray naturalists could be in their beliefs, take the idea that mares could be impregnated by the West wind, which was therefore called "zephyr", from zoe (life) and phoreo (I carry), a notion alluded to in the third Georgic of Virgil.

But why *do* offspring resemble their parents? Because the body of the young creature is developed from a living portion detached from the body of the mother. The discovery of the ovum showed that there is a continuity of substance from generation to generation: some part of the mother's body has not died, for when she dies it is already living on in her child. This is the famous "doctrine of the continuity of the germ-

plasm" : *something* at least is immortal; a speck of female protoplasm is immortal.

The sperm from the male, which is even smaller than the egg-cell, having entered the latter and impregnated it, stimulates it to "division". With no other extraneous aid than this, the ovum begins to grow rapidly into a new creature—new in the sense of separate, but old in the sense that it contains *some* material derived from both parents, some material which is continuous in its descent from the very first of human kind.

A very great deal of the vagueness about reproduction has vanished in the illumination of the microscopic field.

A still further advance into the concrete in Heredity was made in 1900, when the researches of the Austrian monk, Gregor Mendel, were republished, for they were originally written in 1865. These, and the researches which they inspired, threw a very great deal of light on the essential mechanism of inheritance itself. It has been established that in the innermost recesses of the living cell (in its "nucleus") there are minute thread-like bodies which are the carriers of attributes—such attributes in plants as tallness and shortness, the having smooth or

wrinkled seeds, etc.; and in animals such characteristics as length, roughness, smoothness, whiteness and blackness of the hairy coat.

By suitably mating animals possessing combinations of appropriate qualities, hybrids can be produced entirely unknown in Nature before.

This was proof that the experimenter had obtained control of the conditions; in an experiment with guinea-pigs, where one parent had dark smooth hair and the other white rough hair, a type quite new to breeders was produced with white smooth hair. Research workers in Canada have produced a new type of grain which possesses the two attributes of fertility and resistance to a disease ("rust") previously found only in two separate strains of corn. Thus things so elusive as those whose names end in "ness" have been rendered so concrete as to have their physical basis made visible in the microscope.

Finally, so indefinite a thing as blood-relationship has been brought into the category of the definite.

If, say, a rabbit, has injected into it a little human blood sufficiently often, then

some of that rabbit's blood will, when mixed with some human blood, produce a precipitate in the latter. This prepared rabbit (but no other) possesses an *anti-serum* for human blood, and it was originally supposed for no other kind.

If, however, we take some blood from one of the higher apes and add to it some of the anti-serum, we find a certain amount of precipitate produced. The more anthropoid the ape, the more precipitate is found. Hence emerges a totally unlooked-for proof, a chemical one, of our relationship with the monkeys.

Further, if one arranges the monkeys in their descending zoological order and tests with anti-serum the blood of each member of the series, it will be found that the amount of reaction is greatest with the highest apes, and is less and less distinct as we descend the scale, until there is none with the little lemurs, which are not true monkeys at all.

These tests are given with astonishingly high dilutions of blood. This "preciptin" test for human blood has been found so valuable that it has been used in criminal trials to distinguish human blood from that

of the lower animals. Thus so abstract a conception as " blood-relationship " has been made surprisingly definite.

Of course it is in the evolution of the healing art that we have most strikingly the passage from the vague to the concrete. The medicine of the pre-microscopic era was full of sympathies, constitutions, temperaments, dyscrasias, and diatheses ; to-day we recognize these things and work with theories, but as aids in accounting for, not taking the place of, objective realities.

In the fourteenth century the great surgeon of Avignon, Guy de Chauliac, attributed the Plague to a conjunction of the planets Saturn, Jupiter, and Mars in the sign of Aquarius on March 24th, 1345.

The Black Death was said to be due in turn to the poisoning of wells, to the iniquities of the Jews, or to a special outpouring of Divine Wrath.

Later, malaria and influenza were attributed to night air, exhalations, corruptions, vapours, miasmas, and " paludism ". Did not Addison sing—

> " In foreign realms and lands remote,
> Supported by Thy care,
> Through burning climes I passed unhurt,
> And breathed *the tainted air*."

To-day, instead of names we have what we can see and handle—animal parasites, moulds, bacilli, and micrococci. The bacteria are the seed which for ages escaped detection till the microscope revealed that other universe of the infinitely little; then many vaguenesses fled away like morning mists before the rising sun. But what of the soil, of the receptivity? In what does immunity consist?

Immunity from disease is no longer a mere name; the biochemists have bottled antitoxins, preciptins, agglutinins, and bacteriolysins—the chemical responses to parasitic insults.

The latest researches of Dr Gye and Mr Barnard into the causation of cancer introduce us to "germs" so minute that they will pass through the pores of a compressed clay filter. Alone these filter-passers will not infect, will not "cause" cancer, there requires to be simultaneously present in the about-to-be-diseased tissue a second factor, its specific receptivity. This factor has already been separated in a watery extract of cancerous tumours. Alone it will not infect; but in conjunction with the germ or virus, the disease is produced.

Thus, so elusive a thing as the receptivity of the soil for the germ has been captured and corked.

And so knowledge moves majestically, if slowly, from the obscure to the clearer, from the reign of chaos to the reign of law, from the vague to the concrete.

The story of the discovery of the telescope, how it was bound up with that wonderful emancipation of the human spirit from the thraldom of mediæval ignorance and the hatred of scientific light, has been told us by many learned men; but one ventures to think that the discovery of the microscope, which has never yet had its historian or poet, was one fraught with many more beneficent results for humanity. By its scrutiny the invisible but actual sources of most of the scourges of mankind have been discovered; and it would seem that it is in its power, and not in that of fleets or armies, that we must look for the physical salvation of the sons of men. Man may redeem himself from death, not by sweeping the heavens with the space-annihilating telescope, but by peering into the dust of the earth with the space-creating microscope.

We see that the principle of the incarna-

tion of ideas, of the realization in the world of substance of what had been vaguely foreshadowed in the world of mind, is a process which has gone on in science as surely, but perhaps not so conspicuously, as it has in art. The artist succeeds more or less perfectly to incarnate his ideas of beauty in stone, in wood, in metal, or in pigment; but no painter ever yet expressed all the loveliness in his mind, pellucid though his pigments were. The poet strives to give utterance to the majesty of his imagination, but no poet was ever yet satisfied that his words, choice though they were, portrayed all the delicacy of his fancy or the glory of his dreams. The musician is conscious that after he has swept the lyre with melodies of transcendent sweetness, there are unheard melodies that are sweeter still; the preacher whose eloquence stirs the vast cathedral returns home depressed with the thought that his burning words did not rise to the fever-height of his fervour. The saint, aiming at the highest ideals of holiness, has still to confess failure, whether as anchorite, prophet, missioner, or philanthropist.

But it is sometimes given to the man of science to touch, to taste, to handle what

was once only a notion, a suggestion, a forecast either in his own day or in that of a less fortunate predecessor in the earlier times of the history of thought.

VII

JOY IN DISCOVERY

One of the popular conceptions of the man of science is that he is cold and unemotional. The common belief is that he is one who makes records of a large number of facts, from which later he may or may not deduce certain laws. His sympathies, if he has any, are regarded as far removed from the concerns of every-day life, and he is supposed to live in a colourless world of his own where emotion neither flushes his cheek nor brightens his eye. Science, it is imagined, demands this, for must not her worshippers sternly sink their predilections in the search for truth?

Now, it is of course quite rightly insisted that scientific men must make so impersonal a study of Nature's laws that their conclusions shall not be vitiated either by their own feelings or by those of their followers. But ever since Archimedes rushed naked

through the streets of Syracuse shouting "Eureka!" there has been proof that the man of science need not be a stranger to strong emotion. We have had in modern times quite as striking examples of the delight of the discoverer at his discovery, although the expressions of it were certainly more restrained, and more consonant with the police regulations for urban areas. Gaspar Aselli of Pavia also shouted "Eureka!" when by accident he found the lacteal vessels or absorbents, structures of the utmost importance in the economy of the living body. Even he whom most would regard as the high-priest of arid systematists, I mean the Swedish botanist, Linnæus, confessed that he could not refrain from weeping when he beheld the golden gorse in its glory. This chapter will be concerned with recalling some supreme moments of scientific rapture.

The first is that of the dying Copernicus, when his feeble hands were just able to grasp a copy of his great work. It was in 1543, when he was on his deathbed in Frauenburg, that the "De Orbium Cœlestium Revolutionibus" was at last actually published. The whole life of Copernicus may be said to have been devoted to its consummation

in that hour. This father of modern astronomy had taken the degree of Doctor of Medicine at the University of Cracow, but, yielding to his very decided mathematical tastes, he studied mathematics in Rome, and for some years subsequently occupied the professorial chair in that subject. Copernicus was one of those who used the leisure afforded by a sinecure in the Church to devote his energies to the prosecution of science, for his canonry in the cathedral at Warma did not in any way interfere with his astronomical observations. The attitude of the Church towards him is in striking contrast with the fate of his great follower Galileo ninety years later, for the bishops of Capua and Cologne urged the publication of his book thirteen years before he himself would consent to it. Copernicus had good reason to fear the disturbing of accepted beliefs, especially when these beliefs were supposed to be those of the author of " Genesis ". The Church, however, in this case seems to have been in sympathy with her scientifically minded canon, for Pope Paul III (Alexander Farnese) allowed the " De Orbium " to be dedicated to himself, and the expenses of its publication to be borne by the Cardinal-Archbishop of Capua.

Copernicus wrote with boldness, although some have hinted that he purposely delayed the appearance of his book until he knew that he had not much longer to live. But his actual words were strong enough—

> Should there be any babblers who, ignorant of all mathematics, presume to judge of these things on account of some passages of Scripture wrested to their own purpose, and dare to blame and cavil at my work, I will not scruple to hold their judgment in contempt.

It was an epoch-making treatise that his enfeebled hands held before his closing eyes on the 23rd day of May, 1543. Copernicus himself could never have dreamed of the magnitude of the intellectual revolution which his own work on revolutions inaugurated. When we consider the grandeur of the scale of those phenomena studied by astronomers, we ought not to be surprised at their fervent emotion, for, as Young said—

> An undevout astronomer is mad.

Kepler, Newton's most important forerunner, was certainly neither undevout nor devoid of emotion, for in 1619 he could write as follows—

> What I prophesied two and twenty years ago . . .

that for which I devoted the best part of my life to astronomical contemplation, at length I have brought to light, and recognized its truth beyond my most sanguine expectations. . . . The die is cast, the book is written, to be read either now or by posterity, I care not which. It may wait a century for a reader, since God has waited six thousand years for an observer.

Kepler was no mere dry statistician ; he had " most sanguine " expectations ; he was so overjoyed at the verifying of his prophecy that he was perfectly content to let a remote future judge the value of his work.

From Kepler we are led at once to Galileo, " the starry Galileo and his woes ", a man born as it were out of due time. There was little actual joy in his life, although he did derive immense satisfaction from his discovery of the satellites of Jupiter, the phases of Venus, which Copernicus had prophesied, and the details of the surface of the moon. He suffered much in body, and more at the hands of the representatives of that Church of which he always regarded himself as a true son. He had to struggle against the incubus of the errors in *à priori* Aristotelian physics, against tradition with the psychic momentum of nearly two thousand years behind it. He seemed to fail in a supreme

moment, when he put his signature below the words—

> At Rome in the convent of Minerva, 22nd June, 1633, I galileo Galilei, having abjured as above with mine own hand . . .

That was one of the most painful moments in the history of science, for the clouds of obscurantist tradition seemed to roll up and shut out the new light. But it was only a seeming, for that light is unquenchable, and it was destined to burst forth afresh with increased splendour in the Englishman, Isaac Newton. One recalls the inscription for the stone in Westminster Abbey—

> Nature and Nature's Laws lay hid in night;
> God said "Let Newton be," and all was light.

He had first thought of gravitation in 1666—

In 1682 Newton returned to his attempt of sixteen years earlier to explain the moon's motion by means of the assumed influence of gravitation. . . . Newton's earlier data had led to a determination of the acceleration due to gravity at the distance of the moon as 13½ feet per second. The new data changed this result to 15 in agreement with his hypothesis that the force varies inversely as the square of the distance. Stirred to the inmost depths of his usually calm nature by his realization that he was approaching a solution of the

great problem, he had to beg a friend to complete his calculation.

You may well feel an agitating joy when you are on the verge of demonstrating that you have discovered the principle which orders the movements of the earth, the planets, the moon, the comets, the tides, as well as those of all falling bodies. He who could contemplate the intellectual grandeur of this without emotion must be more or must be less than human—

> The very law that moulds a tear
> And bids it trickle from its source,
> Has also formed the earth a sphere,
> And guides the planet in its course.

The next case shall be from the life of Michael Faraday, who, alluding to the life of the man of science, asked: "Do not many fail because they look rather to the renown to be acquired than to the pure acquisition of knowledge and the *delight* which the contented mind has in acquiring it for its own sake?" Someone has described the scene in the laboratory when this investigator first saw a wire which was conducting an electric current begin to rotate under the influence of terrestrial magnetism. "All at

once Faraday exclaimed: 'Do you see? do you see?' as the wire began to revolve, and I shall never forget the enthusiasm expressed in his face and the sparkling in his eyes." Modern science owes to that modest, obscure-born Englishman more than can be easily expressed.

Again, recall the great William Harvey. He was indeed a discoverer, the Columbus of biology. Biologically speaking, we must pronounce the knowledge of the circulation of the blood to have divided the ancient from the modern world. Harvey himself wrote: "Truly in such pursuit it is sweet not merely to toil but even to grow weary, when the pains of discovery are amply compensated by the pleasures of discovery". The intellectual joy that arises from the reward of toil in searching for something unknown and perhaps entirely unsuspected, is one of the purest forms of pleasure permitted to mortal men.

It was in 1628 that Harvey published the small, great work which contained the demonstration that the blood in a very large number of animal types flows continuously from the arteries into the veins. But the actual tubular communications now called

"capillaries", between the arterial and venous vessels, he could not see because they are invisible to the unaided eye. He could but infer their existence. Harvey died in 1657; three years afterwards the Italian naturalist, Marcello Malpighi, actually saw under the microscope the blood streaming through the capillary vessels in the lung of a living frog. His was the first eye to see this verification of the truth of Harvey's great inference,—one day in the year 1660 in the old-world city of Bologna. Malpighi announced his discovery after the manner of his time in a private letter to his friend, the mathematician and physiologist, G. A. Borelli, at Pisa. He wrote, of course in Latin, *magnum certum oculis video*: "I see with my own eyes a great certain thing." It has been carelessly translated, "I see a certain great thing", but this does not give the real sense of the original at all. In the letter the significant words are underlined. Malpighi is evidently excited over his discovery, which he describes as a great and sure fact, or phenomenon, as we should now call it. Not only was the phenomenon he had just observed important or great; but he was absolutely sure or certain of having observed it correctly.

He writes as though fully aware that he of all men was the first to behold this wonder, and so the beautiful network of vessels in the lung is still called *rete mirabile Malpighii*. He devoted much time also to the elucidation of minute details of the structure and metamorphosis of insects, particularly the silkworm. After years of this trying work, often interrupted by inflammation of the eyes, he could write—

> Nevertheless in performing these researches, so many marvels of Nature were spread before my eyes that I experienced an internal pleasure that my pen cannot describe.

And yet Malpighi has been considered as very unemotional!

For another case of scientific joyousness we pass north to Holland, to the little town of Delft, where one Anthony van Leeuwenhoek worked incessantly with his microscopes during a very long life, for he was born in 1632 and died in 1723. His life was placid and uneventful, if we except a visit he had in 1698 from the Tsar Peter I, commonly called Peter the Great, who was particularly delighted at the spectacle of the blood circulating under the microscope in the tail of a small eel.

Amongst the many things which Leeuwenhoek saw for the first time was the circulation of the blood in what are called "systemic" capillaries, that is capillaries other than pulmonary. The latter had been already observed by Malpighi in 1660, but systemic capillaries were not seen until 1688. Leeuwenhoek used the translucent tissues of certain aquatic animals, such as the web of the frog's foot, the tail of the tadpole, and the tail of the little fish called "stickleback". He has left an admirable description illustrated by figures of the manner in which arteries end in capillaries and capillaries become veins in the tail of the fish. Leeuwenhoek was the first to behold the blood passing unceasingly in the same direction through the capillaries from the arteries to the veins, and so he discovered the circulation for himself.

In a fuller way than that of Malpighi, he verified Harvey's induction that the blood moves always and only from arteries to veins. Harvey could not discern capillaries, not only because he had no microscope of nearly sufficient power, but also because the walls of these minute vessels are perfectly transparent in their state of nature. To be

quite accurate, we must say that neither Malpighi nor Leeuwenhoek saw capillaries in the sense in which we now see them in dead " fixed " preparations, or in " sections " of tissues beautifully stained and differentiated from the cells and fibres around them. But they both saw blood moving in minute tubes, whose transparent walls they very properly assumed to exist.

Leeuwenhoek, evidently derived immense satisfaction from viewing this wonderful spectacle. To the secretary of the Royal Society of London he wrote—

> But now that I hear that more credit will be given to my words when I mention the names of those who have partly seen the aforesaid circulation of the blood about which I write to your honourable Society and which I have discovered, I have no objection to mentioning, instead of many, such as I trust will deserve most belief, as for example Mr. Cornelius Gravesande, M.D., and ordinary professor of anatomy and surgery, and also Councillor and late sheriff of this town, Mr. Cornelius Valensis also councillor and late sheriff, Mr. Antoni Heinsius, LL.D., councillor and *pensionaris* of this town, late Envoy Extraordinary to His Majesty, the King of France, and not long ago Ambassador of this State to the Court of His Royal Majesty of England. To these gentlemen . . . I have shown the true circulation of the blood as distinctly as we see with our naked eyes the current of the water in a running river.

Commenting on the circulation in the tail of the tadpole, he exclaimed: "A sight presented itself more delightful than any mine eyes had ever beheld".

Leeuwenhoek was willing to share his joy in discovery, for when he found the embryo of Unio, the fresh-water mussel, he had to call in his daughter and his engraver to watch it swimming about "for three whole hours". It is recorded that he was particularly delighted with finding embryo eels in the body of the female, for he had been specially challenged to show how eels are bred. There was more than the usual nonsense believed in his day about the reproduction of eels. Leeuwenhoek was the first microscopist to see a bacterium.

Another supreme moment in science belongs to the life of one of the greatest benefactors the human race has ever seen, Edward Jenner, who was born in 1749 and died in 1823. Jenner's careful observations had shown him that certain persons, usually dairymaids, who had contracted the mild disease of cows called cowpox or Vaccinia, were immune from the far more serious human disease called smallpox or Variola. He soon saw how a crucial experiment could be planned,

namely, to inoculate someone with cowpox, thereafter with smallpox, and demonstrate that in the latter case the disease would not develop. In the year 1796 a dairymaid, Sarah Nelmes, took cowpox, and on May 14th Jenner inoculated a healthy boy—James Phipps—eight years old, with some of the liquid from a "sore" on the woman's arm. The boy had that slight fever and reaction we should now call "the vaccination taking", and remained perfectly well for six weeks. Jenner then decided to put his theory to the test and actually inoculate the child with smallpox.

On July 1st this was done. Time passed, and the boy showed no sign whatever of the loathsome disease. Jenner, as one might well expect, was very much elated, and at once wrote the news to his friend, Mr Gardner. He tells how James Phipps had been inoculated with cowpox, and how he looked exactly as though he had caught this complaint in the usual way through contagion. "But now listen," he continues, "to the most delightful part of the story. The boy has since been inoculated for the smallpox, which—*as I ventured to predict*—produced no effect. I shall now pursue my experiments

with redoubled ardour." Joy in scientific discovery is ever an incentive to further enterprise. July 19th, 1796! A supreme moment in the development of the science of medicine and for the future happiness of the human race! No wonder that the German Government proclaimed the day of Phipps's inoculation as a public holiday. Shortly after this date Mr Cline, the well-known London surgeon, wrote to Jenner: "I think the substitution of cowpox poison for smallpox poison promises to be one of the greatest improvements that have ever been made in Medicine". But no contemporary of Jenner in his most sanguine moments could have foreseen the magnitude of the boon which the modest country practitioner was to confer on suffering mankind.

An example of joy aroused by a scientific triumph, and—not less—of grief at the limitations to the beneficent work of science, may be taken from the life of Pasteur. He ranks with Jenner as one of the greatest benefactors of mankind. Pasteur discovered the cause and cure of the souring of wine, of the silk-worm disease, of anthrax, of fowl-cholera, and finally of hydrophobia. Using the method of inoculation of attenuated virus, in itself

virtually an extension of the principle involved in vaccination, Pasteur after a masterly series of experiments felt justified in believing that he had found the natural or biological cure for hydrophobia or rabies—one of the most awful diseases which man shares with the lower animal world. He had come to the conclusion that these anti-rabic inoculations cured the more effectively according as they were given as soon as possible after the patient had been bitten by the rabid animal—dog, wolf, or fox. The first case sent to Paris for treatment (July 6th, 1885) was that of a little Alsatian boy, Joseph Meister, nine years old, who two days previously had been badly bitten in fourteen places by a mad dog. After days of deep thought, Pasteur decided to inoculate the child with weakened anti-rabic virus on July 11th, and he performed the final injection on July 16th. He had been prepared to inoculate himself with rabies, and then give himself the anti-rabic material, but little Meister provided him with the test case. To his son-in-law and biographer, Valery-Radot, Pasteur wrote: "I think great things are coming to pass". And again: "I have an ardent desire to snatch little

Meister from death ". When the last inoculation had been given, the child went to bed to sleep peacefully, while Pasteur in an agony of anxiety spent a sleepless night. But as the child was perfectly well on August 3rd, he could write: "Very good news of the bitten lad". Pasteur had all the direct and sympathetic insight of the cultured Frenchman, all his keen delight in the victories of science—always tempered in his case by a vast human tenderness.

When, some time later, he knew that he could not save the life of Louise Pelletier, bitten on October 3rd, but not brought to him until the 9th of November, he stood holding her hand as spasm after spasm of the diabolical disease convulsed her, and then burst into tears—a prince among scientists weeping, a man, a tender great man! His joy on demonstrating that sheep infected with the deadly anthrax would not die if subsequently inoculated with the weakened virus was very intense. When he received the telegram informing him that all the infected sheep were dead or dying, and that every one of the inoculated animals was alive and well, his delight was deep, and had at once to be shared with his children.

"Joy reigns in the laboratory and in this house. Rejoice, my children," were the concluding words of a letter written at this time.

On one occasion Pasteur said: "Nothing is more agreeable to a man who has made science his career than to increase the number of discoveries, but his cup of *joy* is full when the result of his observations is put to immediate practical use". Monsieur Radot remarks: "The emotions of *savants* are all the deeper that they are not enfeebled, as in so many writers or speakers, by the constant use of words which end in wearing out the feelings".

One may recall, too, the great English surgeon, Joseph Lister. His discovery that wounds, whether of accidental origin or produced by the surgeon, "go bad" because infected by germs of putrefaction—that is, by micro-organisms present practically everywhere—is of cardinal value in the healing art. Lister's practice of employing chemicals or "antiseptics" to prevent or reduce this putrefaction in wounds has not only occasioned the rebirth of surgery, but along with the use of the anæsthetic powers of chloroform has been the means of banishing surgical pain

and much pre-operational anxiety from the human race. These stupendous benefits were conferred upon mankind about 1867 by this gentle English Quaker, while Professor of Surgery in the University of Glasgow. One of the chief troubles before his time was the coming loose of the ligatures or cords used in tying arteries to prevent their bleeding. These insoluble tapes or strings frequently slipped off the blood-vessels as a result of the disintegrating agencies in the soft edges of the putrid wound, so that the patient might lose much blood in this so-called " secondary hæmorrhage." A large part of Lister's early success was due to the introduction of the catgut ligature, a cord of animal and therefore absorbable material, so treated chemically (chromicized) as to resist putrefaction and yet not become an irritant to the living tissues of the healing wound.

Early in 1868 Mr Lister had the opportunity to put these ideas into practice when he decided to perform the major operation of tying one of the great blood-vessels for iliac aneurysm in a patient, a lady of fifty-one years of age. It is in letters to his father that we find the best accounts of this case.

In one dated February 2nd he wrote: "Six weeks after the operation I found the ligature still there, but surrounded on all sides by perfectly healthy, firm tissue, the thread (silk) having caused none of the irritation which it does when not managed antiseptically. . . . Hitherto the patient's progress has been all that can be desired. I imagine there never before was a patient in so good a state after this very serious operation". Ten days later he wrote again: "I send just a few lines to give what I know will be the welcome news that the case of the ligature of the external iliac continues to do as well as can be wished. . . . I think the case may now be considered a success. I don't think any case ever excited me so much".

We have to remember that to exhibit strong emotion is a thing forbidden to members of the Society of Friends, so that Lister's phrase "excited me so much" means considerably more than it would if used by one of a different religious school. Although he did not at any time in his life give way to boisterous expression of his feelings, it is perfectly clear from the admirable record by his nephew, Sir Rickman Godlee, that Lord Lister was a man of powerful emotion

and of deep convictions. Godlee's remark on this correspondence is: "In Lister's letters to his father this case is referred to again and again; it evidently impressed him profoundly". It impressed him profoundly because it was the first serious operation of its kind performed on principles that were at that time absolutely new and entirely untried. The surgeon's task is always responsible and anxious; but this occasion was one of peculiar import, for a pioneer was putting novel and extremely unpopular views to the test in a case where a human life was involved. By all, save a few "cranks" whom we shall always have with us, Lister's discovery has been acclaimed as one of the cardinal advances in scientific medicine, and as one of the most beneficent presentations that science has ever made to suffering humanity. The late Professor Rudolph Virchow, when he delivered the Huxley Memorial Lecture on a subject which involved constant references to Lister's work, turned round from the lecture desk and grasped the hand of the venerable master. "Equally touching it was when, at a small dinner given by Virchow, on the occasion of Lister's eightieth birthday, to his family and a few intimate friends, he

did such eloquent homage to the greatness of Lord Lister's work that the latter could scarcely restrain his emotion." Not all men of science are the cold-blooded molluscs which in some quarters they are thought to be. When representatives of the world's learning were congratulating Pasteur on his seventieth birthday, Lister—as President of the Royal Society—advanced to the dais and fervently embraced the great Frenchman. This scene is commemorated in a fine painting. Speaking of it, Monsieur Vallery-Radot says: "The sight of these two men gave the impression of a brotherhood labouring to diminish the sorrows of humanity".

Keats surely struck the right note when he spoke of the ecstasy of "some watcher of the skies when a new planet swims into his ken". We know how Simpson rejoiced over the first child born to the exhausted mother painlessly through the influence of the soothing vapour of chloroform. We know the joy of Lister when, for the first time in the history of surgery, a compound fracture healed without inflammation and without giving rise to suffering under the antiseptic effect of carbolic acid. We know how delighted was Graham Bell when he

first heard human speech conveyed over the wires of his telephone. We know how Edison was thrilled when, having spoken to his wax cylinder, he heard every word reproduced. Lord Kelvin, when he had perfected one more of those exquisitely delicate electrical instruments of which he was the inventor, would have it brought up and placed on the drawing-room mantelpiece so that he might exult at his leisure over the latest product of his genius. And the daughter of Sir David Brewster wrote thus of her father at work in his physical laboratory: "After a while he would forget I was there; and I have often seen him suddenly throw himself back in his chair, lift up his hands and exclaim, 'Good God, Good God, how marvellous are Thy works!'"

There is a holy joy in seeing Law extend her placid reign into the regions where Chaos rioted, in seeing scientific light steadily and majestically pushing back the circumambient darkness of ignorance. This joy of the creative intellect is probably one of the most exalted and altogether lovely of the human emotions. It comes as the reward only of undaunted effort, of that persistent search for causes which is of the very essence

of science. The pleasures of scientific discovery are as worthy of poetic celebration as the pleasures of memory, the pleasures of imagination, or the pleasures of hope; inasmuch as they include all these and yet transcend them, the pleasures of discovery can but be awaiting their Milton. If it is true that "There's not a joy the world can give like that it takes away", then it is certainly as true that there is a joy in creative discovery with which science rewards her lovers, a joy which the world can not give, neither can it take away.

VIII

POETRY AND SCIENCE

"Poetry," said Coleridge, "is not the antithesis of prose, but of science." Now, we would all agree that the differences between poetry and prose are conventional or arbitrary. We all know prose that is poetical, and we know "poetry", or at least verse, that is very prosey—that is to say, not poetry at all.

But is poetry the antithesis of science? In a sense, yes; for science is knowledge and poetry is feeling. This is the view expressed by the late Prof. Churton Collins: "What I want to emphasize is that the tendency of science and what is necessarily connected with science, tone of mind, way of looking at things and the like, is an opposite tendency to the essence and spirit of poetry and what is implied in poetry".

"Modern language," says Mr Pearsall Smith, "is for the purpose of use, not beauty;

and these abstract terms in 'ism', 'ist' and 'ize', dull, dreary and impossible for his purpose as the poet finds them, are yet indispensable for the hard thinking of science and for social and political theory." In other words, then, there *is* a struggle.

The poet is the person who can say, better than anyone else, what everyone else is feeling. The man of science desires to know, first of all, not necessarily not to feel, but first to know. He desires facts, their interrelations, their interpretation. To science everything is of importance: to the scientist, as to Wesley, "the whole world is" his "parish": and everything is of equal importance, the microbe and the whirlwind. There is science in everything; but it takes a very sympathetic poet indeed to find poetry in everything. Mr Kipling has found it in the engines of a modern steamer.

Poetry is an attitude of mind—a mode of regarding things—the emotional disposition. Poetry is the reverent love of beauty. There are certain persons who are poets and yet have never written a line of prosody or two words that rhymed.

To science, the eye, for instance, is a camera obscura of definite but adjustable

focal power for the purpose of placing a minute, inverted, real image of external objects on a sensitive surface in connection with the brain; but to the poet, "her eyes are homes of silent prayer"; and to the poet it is possible to "make April of her sunny eyes".

Mr Ruskin defines science for us as follows: "All true science begins in the love, not in the dissection, of your fellow-creatures; and it ends in the love, not in the analysis, of God" (Deucalion). Now, if he had just said "poetry" instead of science, we might have been able to agree with him. Without venturing to say how it affects theology, I fancy it will not be questioned that the carrying out of this principle would be disastrous in anatomy and surgery.

Science is knowledge, so-called "empirical knowledge", as distinguished from philosophy which is wisdom, something alleged to be higher than science.

The scientist, consumed with a reverent inquisitiveness to know facts in Nature, and why they are thus and not otherwise, accepts Nature—matter and mind—as real things of which he may investigate the properties; but the philosopher begins by questioning

everything, and, endeavouring to get behind what he calls "phenomena", tries to construct the world from such first principles as "pure being", "absolute existence", etc.—the world of Noumena. But the man of science does not discuss "existence" but, the existing being, why it is here and not there, of such qualities and not of others, and so on. The scientist sets aside his personality and strives to investigate unbiassed and to generalize without fear of consequences.

Poetry is to the love of beauty what science is to the love of fact. Poetry is above all things pure beauty in words, as a picture is beauty in paint, music beauty in sound, and a statue beauty in stone. Poetry must first of all be beautiful; supremely beautiful in thought and expression. Naturally this is found in the love-songs of a nation. As an example take Sir W. S. Gilbert's lines—

> "Thou the stream and I the willow;
> Thou the sculptor, I the clay;
> Thou the ocean, I the billow;
> Thou the sunrise, I the day."

Or, as another example, take Byron's description of a sunset in Greece—

"Slow sinks, more lovely ere his race be run,
Along Morea's hills the setting sun;
Not as in Northern climes obscurely bright,
But one unclouded blaze of living light.
O'er the hushed deep the yellow beam he throws,
Gilds the green wave that trembles as it glows."

Poetry is the gift of showing to others how beautiful Nature is—the beauty everywhere, the beauty no less "in the bellow of the blast" than in the placidity of the lake mirror: poetry tells us beautifully how beautiful Nature is. Thus it is, I think, so much of Wordsworth's writing is not poetry, but prosodical philosophy: he tells us (but always beautifully) how wonderful and full of meaning rather than how beautiful Nature is. Not that Wordsworth did not write poetry: he did, but he wrote more philosophy. To discern this beauty and still more to express it, needs the discerning eye and the gift of tongues: these are as special gifts as the power to discover and to correlate facts. There is the poetical disposition or instinct, just as there is the practical or money-making. There are persons, true poets in their outlook on Nature, who never wrote and never will write ten words of rhyme.

Poetry and science are opposed not so

much in their ends as in their means. Both poets and scientists are interested in daisies, for instance. The beauty and fragrance of the daisy would prevent the poet from dissecting a daisy in order to find out how it was constructed. Tennyson said the daisies blushed that he could be so coarse as to tread upon them. The poet is not in the least interested in the structure or classification of the daisy or any fact about it regarded *as a fact*. He does not know much when he looks at the daisy, but he feels intensely, so that he exclaims, " wee, modest, crimson-tipped flower ".

To the mere scientist to call the daisy " modest " is meaningless; he has not personified it: it has indeed life, he admits, but life that knows no emotions; the poet, however, is all emotion, and it overflows and endows even the daisy with some of it. The man of science understands this even when he does not share it. It is one phenomenon more for him to investigate, the psychology of emotion; the tendency to anthropomorphism. The poet compares things which to the man of science have nothing in common. For instance, Shakespeare's splendid comparison—

'O setting sun, as in thy red rays thou dost sink to-night,
So in his red blood Cassius' day is set."

Or Burns'—

"The opening gowan wat wi' dew,
Nae fairer is than Nannie, oh!"

are poetry, but only for the sympathetic, only for "the man of feeling". I remember reading Burns' "Mary Morrison" to a man who had asked me to quote something typical of that poet, and his reply when I had finished was: "What awful rot"—

"'Yestreen, when to the trembling string,
The dance gaed thro' the lighted ha',
To thee my fancy took its wing,
I sat but neither heard nor saw:
Tho' this was fair and that was braw,
And yon the toast of a' the toun;
I sighed, and said: 'Among them a'
Yet art na' Mary Morrison.'"

. . . . .

"If love for love thou wilt na' gie',
At least be pity to me shown;
A thought ungentle canna be,
The thought o' Mary Morrison."

Whoever wrote that was a poet—peer or ploughman, it matters not, he was a poet.

The poet uses expressions devoid of any meaning at all to the unsympathetic. Thus

sings Byron at the close of his exquisite lines to Augusta—

> "In the desert a fountain is springing,
> In the wild waste there still is a tree,
> And a bird in the solitude singing
> That speaks to my spirit of thee."

Unless these similes are accepted in the agony of spirit in which they were written, they are indeed trivial. Or, again, take the stately lines in Gray's "Elegy"—

> "The boast of heraldry, the pomp of power,
> And all that beauty, all that wealth e'er gave,
> Await alike the inevitable hour—
> The paths of glory lead but to the grave."

mean very little to the non-poetic soul.

Oh yes, he says it just amounts to this, that all sorts of people, high born and low born, eminent and obscure, must all die sooner or later. Yes—but the poet is the person who can tell us so beautifully that we must all die that the music of his words takes the sting from death.

But it seems to me that poetry and science have some things in common. In the first place, there is nothing too familiar or trivial to be sung of by the poet or looked into by the man of science. The poet says—

"To me the meanest flower that blows can give
Thoughts that do often lie too deep for tears."

To neither the poet nor the scientist are there such things as "weeds": to the poet they are but flowers wilder than the rest: to the scientist they are plants just as much as, and no less than, are the lilies. But it would be a mistake to suppose that it is only beauty that the poet sees in things: having personified things, he next interprets them: "he finds sermons in stones, books in the running brooks", and he used to find "good in everything". Here he comes close to the scientist's position: the scientist can discourse "On a piece of chalk", as in Huxley's famous lecture; but the poet can discourse and sing as well. Thus poetry long preceded science; men felt long before they knew. Primitive peoples have always personified; have seen the living in the non-living, gods, goddesses and spirits of the stones, the brooks, the trees, the clouds, the wind and the whirlwind. Did not even Cowper write—

"He plants his footsteps on the clouds
And rides upon the storm."

To the early poet all things were alive, all

spoke to him: all were beautiful, save the bad spirits he had to appease. Thus all Nature is subject to changes as the poet himself changes: is he sad in the autumn, then he sings—

> "Blow on! sad winds, for ye are Heaven's sighing;
> Fall! faded leaves, for ye are Earth's own tears."

or, again—

> "Unless I be by Sylvia in the night, there is no music in the nightingale."

Hence so much of the Bible is the most beautiful poetry—

"Judah is a fruitful bough whose branches run over the wall"—that thought could have been expressed very differently.

One can see at a glance that the inspired writers were not so much concerned about facts and causes—science is a search for causes—as about the grandeur and the majesty of the earth and sky. "When I consider Thy Heavens, the work of Thy fingers, the moon and the stars which Thou has ordained; what is man, that Thou art mindful of him, or the son of man that thou visitest him"; and again: "The Heavens declare the glory of God, the Firmament showeth his handiwork".

The relations of poetry to religion on the one hand and to science on the other have always been full of interest. As might be expected, the relationship between religion and poetry is much more intimate than between science and poetry. For religion is very largely a matter of emotion, and faith is the antithesis of knowledge : " Believing where we cannot prove ". Science, it has been said, is cold, dispassionate and emotionless ; she analyses, tests, proves or disproves ; and her conclusions are what they are, whether we like them or not ; our emotions do not enter into the case at all.

Science needs no sympathy or emotional support—she is studied for her own sake, and knowledge is its own reward. Poetry may come and celebrate her achievements, but that does not help her to fresh conquests ; she is all-sufficient. Not that the study of science makes men self-sufficient ; science is so interesting that her students are so happy in their work that we may say of them what the Scottish poet Logan said of the cuckoo—

" Thou hast no sorrow in thy song,
No winter in thy year."

But with religion it is all quite different. Religion without poetry is like the lily-of-the-

valley without perfume. Religion without the "beauty of holiness" is the most repulsive form which the activity of the mind of man can take. Poetry clings to faith like the scent of the roses to the bowl—

> "You may break, you may shatter the vase, if you will,
> But the scent of the roses will cling to it still."

Only a religious poet could have said—

> "Though He slay me, yet will I trust in Him."

To the Oriental, facts have much less interest than moralizings and speculations. The Hebrew poets in particular were not interested in facts and laws, but in moral grandeur. To poetry, the wind "bloweth where it listeth": to science it moves from places of relatively high to those of relatively low pressure. But is the poet wrong? Not so: if you only allow him to personify the wind first.

Again, to science, nothing is "common or unclean". The weed, the slug, the parasitic worm and the death-bringing microbe are all as worthy of study as the rose, the bird of paradise, the diamond or the sunset. To science, the digestion of one's breakfast is as much a natural phenomenon requiring

explanation as an eclipse of the sun or the eruption of Krakatoa, or the return of Halley's comet.

In neither science nor poetry does familiarity ever breed contempt: we shun the "nil admirari" as an absolutely accursed thing. Carlyle said the rising of the sun was a daily miracle: so is the digestion of our dinner: for we do not know yet *how* our food becomes part of ourselves.

Tennyson was surely right when he said that if we knew the "flower in the crannied wall" thoroughly, "all in all", we should know what God and man is. Now Carlyle did not believe there was nothing common or unclean, for he speaks of the dissection of a porpoise by a friend of his as "gutting this shapeless bulk of stinking flesh". But the porpoise and its shape was as much a part of divine ordering as Carlyle and his.

But is there no beauty in science? Is beauty not revealed in the minute details of the eye and the ear? Doubtless it is an intellectual and not a sensuous beauty that is here, but in these exquisite organs there are, for instance, the daintiest and most perfect of mosaics hidden from all eyes except those behind the microscopes.

Have we not in science the beauty of adaption of means to ends, the beauty of mechanism, device, construction? Animate nature is full of them. The mandibles of a flea are exceedingly beautiful under the microscope. To some minds the symmetry of snow-crystals and the sharpness of the sting of the bee are full of beauty. The scientifically minded finds beauty in the very law and order of Nature. Is not the onset of an eclipse at the precise instant at which it was predicted hundreds of years before a beautiful thing? Is not the return of a comet at the predicted moment after seventy-five years of absence from our firmament an intellectually beautiful thing? Those who predicted its return have long gone to dust, and when it next appears, to dust we shall have returned also.

Is it not beautiful to watch the beating heart, that small, powerful organ which has never missed more than a beat or two since we were born, which has been incessantly driving the living blood round and round the body against resistance and through its own cavities, guarded by the most exquisite valves? We did not start it and we shall not stop it; our existence depends on its existence.

Now it is science, this sanctified common-sense, that has revealed these beauties. Here it seems to me that poetry and science meet. The reverent scientist is a poet; and knowledge, the results of the sanctified desire to know, can be expressed in poetry. Some of the scientific poets have been Goethe, Erasmus, Darwin and Oliver Wendell Holmes. Arbuthnot, Goldsmith, Akenside and Keats had all studied Medicine. Sir Ronald Ross and Sir Charles Sherrington have published verses.

Sir Ronald Ross, K.C.B., whose discoveries as to the origin of malaria and whose fearless crusade against its ravages are so well known, has published a book of poems. He is speaking of the microscopic poison of malaria—

> "Seeking his secret deeds
> With tears and toiling breath,
> I find thy cunning seeds,
> O million-murdering Death!"

Then as he reflects on the cure, something so simple, just using mosquito nets and draining the breeding-pools of the pests, he continues—

> "I know this little thing
> A myriad men will save.
> O death, where is thy sting!
> Thy victory, oh grave!"

The form may not be of the highest in

poetical art, but the spirit of poetry permeating the man of science is here.

Keats was quite wrong when he complained that Newton, by discovering the true cause or origin of the prismatic colours, had destroyed all the poetry of the rainbow. To the physical beauty of the rainbow, Newton added the intellectual beauty of a mathematical explanation. James Thompson, another poet, at least did not agree with him: so that poets can differ as much as doctors—

"First the flaming red
Sprung vivid forth; the tawny orange next,
And next delicious yellow; by whose side
Fell the kind beams of all refreshing green.
Then the pure blue that swells autumnal skies
Ethereal played; and then of sadder hue
Emerged the deeper indigo.
While the last gleamings of refracted light
Died in the fainting violet away."

Sir James Dewar in one of his scientific lectures at the Royal Institution handed round Shelley's "Address to the Cloud" to illustrate his remarks. Thomas Campbell, however, would seem to have agreed with Keats, for he said—

"Triumphal arch that fill'st the sky
When storms prepare to part,
I ask not proud philosophy
To tell me what thou art."

But not alone is a certain kind of poet in opposition to science, the person known as the philosopher or metaphysician also is. He is not so much in opposition to it as that he looks down upon it from a height where he regards his own speculations as of more value than enquiries into "merely empirical" matters. We need mention the names of no living persons, but illustrate what we mean once more from Carlyle, who, whatever else he was, was a philosopher. Carlyle's view was the transcendental one: the "it" in the sentence I am just going to quote is what his biographer calls the "spiritual principle" of the world. "Atheistic science babbles poorly of it, with scientific nomenclature, experiments and what not, as if it were a poor dead thing to be bottled up in Leyden jars and sold over the counter." The philosopher and certain poets who have much in common agree in hating and despising science: the philosopher from above it, the poet from outside it. We would suggest the same treatment for both: make them go through a day destitute of the benefits of everything discovered by science. Just ask them if they would like to get their letters twice a year, and take nine

months to go from England to India! Ask them to cook their own breakfast with a steel and a flint, and dine off a root or two. This treatment may always be recommended when people begin to speak disrespectfully of science. It is science and science alone that has increased the comfort, the wealth, the progress of every nation. Science creates manufacturers and arts, creates work for millions. Take away our glass, our railways, our steamships, our bridges, our electrical machinery and our printing, and you take away the means of living of millions of men. The more you discover, the more will there be for people to be employed upon.

Science is rightly credited with power: "knowledge is power": but the pen, the poetical pen very often, is mightier than the sword. Now and again the queenly pre-eminence of poetry has been acknowledged even by men of action, exponents of the science of war. "I would rather have written that poem than take Quebec", said Wolfe of Gray's "Elegy". Fletcher of Saltoun is credited with the saying that the person who makes a country's songs is of more account than he who makes her laws.

But, lastly, there is one more thing common

to poetry and to science, which is, that neither can grow old—" time cannot stale their infinite variety ". A fact is a fact for ever : and a thing of beauty, we have it on the high authority of the poet, " is a joy for ever "—both the fact and the fancy, then, are for ever. But I have noted a tendency to belittle facts which have been discovered long ago. I have heard it said : " Oh yes, but that is very old ". If it is a fact, it has perennial youth : a fact stands for ever in majesty as a fancy stands for ever in beauty ; both are " jewels, five-words long, that on the stretched forefinger of all time, sparkle *for ever* ". Not less but more valuable as time goes on is every fact and every true inference from facts ; and it is not less so with fancies. Will not the sound common sense of Biron in " Love's Labour's Lost " remain for ever ?—

" These earthly godfathers of Heaven's lights,
That give a name to every fixed star,
Have no more profit of their shining nights
Than those that walk and wot not what they are."

Can the terseness ever desert such a glorious declaration as this ?—

" The drying of a single tear hath more
Of real fame than shedding seas of gore."

Will time ever take the grace from Milton's words in describing Prosperine gathering flowers—" herself a fairer flower " ? Can the compactness and graphic vigour ever depart from the closing verse of " Belshazzar's Feast " ?

" Belshazzar's grave is made,
His kingdom passed away ;
He, in the balance weighed,
Is light and worthless clay.
The shroud, his robe of state,
His canopy, the stone,
The Mede is at his gate,
The Persian on his throne."

Will time ever tarnish the beauty and dignity of that song to Greece in " Childe Harold ", which contains the verse beginning—

" Yet to the remnants of thy splendour past,
Shall pilgrims pensive but unwearied throng ;
Long shall the voyager with the Ionian blast
Hail the bright clime of battle and of song ;
Long shall thy annals and immortal tongue
Fill with thy fame the youth of many a shore.
Boast of the aged ! lesson of the young !
Which sages venerate and bards adore,
As Pallas and the Muse unveil their awful lore."

Will the fineness ever depart from a stanza such as this in the same poem, describing the castles of the Rhine ?—

"And there they stand as stands a lofty mind,
Worn but unstooping to the baser crowd;
All tenantless, save to the crannying wind,
Or holding dark communion with the cloud.
There was a day when they were young and proud,
Banners on high, and battles passed below—
But they who fought are in a bloody shroud,
And those that waved are shredless dust ere now;
And the bleak battlements shall bear no future blow."

Will the purity and subtlety ever vanish from that marvellous metaphor of Shelley's?

"Time, like a dome of many-coloured glass,
Stains the white radiance of Eternity."

Can the sheer aptness of delineation and exactness of picturing ever pass from Tennyson's lines in "In Memoriam"?—

"And ghastly through the drizzling rain,
On the bald street breaks the blank day."

Or for absolute truth shall the incomparable *exactness* of what is meant ever desert these words?—

"All the land in flowery squares, beneath a broad and equal blowing wind, smelt of the coming summer."

Or these—

"In that fierce light that beats upon a throne and blackens every blot."

Or shall all eternity ever take the ineffable sadness from these lines of the late laureate ?—

"And the stately ships go on
To their haven under the hill ;
But oh ! for the touch of a vanished hand,
And the sound of a voice that is still.
Break, break, break !
At the foot of thy crags, oh sea !
But the tender grace of a day that is dead
Will never come back to me."

IX

HUMANISTIC CULTURE IN ENGLISH LITERATURE

Culture is an attitude of mind rather than a possession of mind ; it is an intellectual atmosphere rather than intellectual property. It is having intellectual sympathy rather than having learning. Someone has said it is being able to get the greatest amount of enjoyment out of life. A cultured person need not be technically trained, but he must have intellectual receptivity and æsthetic susceptibility. The most learned archæologist, stuffed full of the most recondite facts about the remotest past, whether of Rome, Greece, Egypt or Assyria, need not be a cultured man ; he might have no sympathy whatever with natural science, nor condescend to understand the making of England, nor show any interest in music or in art. Culture is intellectual, æsthetic and moral reverence.

Knowledge may be power, it is not

necessarily culture; the prize-fighter has knowledge, perhaps the most extensive knowledge about all the prize-fights that have ever happened since the beginning of time, but that does not entitle him to be considered a cultured person. Capacity even is not culture; ability to rule a state is not culture. Oliver Cromwell was a very able man, I doubt whether we should call him cultured. We can have capable barbarians and most able Philistines, just as on the other hand we can have erudition and education without culture.

Now this very idea of culture as distinguished from learning is a Greek one. The antithesis between the fully developed human organism—fully developed in body and mind—and man in the wild or natural state, unendowed, unenlightened, unrestrained in instincts and proclivities, is a Greek conception. The Greeks took themselves as representing this culture; this state of mind as other than the natural and untrained condition of man; and all persons outside themselves they called barbarians, the uncultivated. This Greek ideal was realized only after physical labour and mental toil—gymnastics and study—had altered body

and mind from the wild, rough state of nature.

The whole attitude of the Greek mind was a cultured one; it not only longed for knowledge for "some new thing", but it craved to be surrounded with beauty, it yearned for the comely, the graceful, the reposeful. The Grecian ideal was a soul undistressed by sordid cares, a countenance calm in the contemplation of the dignified, the noble in thought and action and the sweet in sound. Grace in action is particularly Greek; the Nike Aptera is pre-eminently a Greek conception.

Of course this ideal was a Pagan one; and we must take care not to read into it the conceptions of Christian ethics. Grecian culture included much that was not only contrary to but positively repugnant to Christian morals. The Grecian ideal was suitability not righteousness, power not purity, fitness not holiness, the grace of form and carriage not the grace of a contrite heart. The Greek admired subtlety of dialectic distinctions far more than honest dealing.

The beauty that is in science he hardly dreamed of, for, save mathematics, the sciences were unborn; the beauty of holiness was

inconceivable ; the beauty of thought, of introspective philosophy, rather than of conduct, was what stress was laid on. These ideas and ideals passed over into the Roman empire, and in course of time Rome became Hellenized ; all that was best there was an importation ; her philosophers, poets, sculptors and physicians were either Greeks, of Greek descent or of Greek training. Even the great Galen (the father of medicine for a thousand years), physician to Marcus Aurelius, was not a Roman ; he was a Greek born at Pergamos, and he wrote in Greek, and his writings were not translated into Latin for centuries after his death. Later Roman culture became practically synonymous with Grecian thought, and the Romans learned Greek as we learn French and German; the ideal Roman became a sterner, harder version of the Greek. Of course just before the fall of the empire, the Romans were more effeminate than the softest Greek had been. The sweetness and light had passed over from Greece to Rome ; but henceforth there was less sweetness and more strength, less philosophy and more love of conquest, less light and more law-giving. Roman thought was Grecianized, and then—Rome

fell. When Rome fell, the dark ages set in, and these ages were dark because the light of culture had been put out.

Christianity had indeed supplanted Paganism, but Christianity in itself was not culture, and the dark ages were dark because Christianity was interpreted and practised without culture.

As the keynote of the classical Paganism had been culture without moral goodness, so the Christianity of the dark ages was goodness without culture; the result was the monk, the anchorite. The monk, when he was not ignorant, bigoted or immoral, was a sincere recluse, learned in the limited learning of his day, but narrow, Oh! how narrow, as narrow as piety without culture could make him.

Hence, there was nothing for the common people; no science, no natural knowledge—that was to come—no art that was buried beneath the ruins of the Roman empire, almost no vital religion, nothing but the carrying out of forms and ceremonies behind stone walls. The poor man outside had nothing to do but to till the ground in order to feed himself as well as the holy but unproductive recluses inside the cloisters.

The emptiness, the blankness, the intellectual dreariness of the life of the ordinary man of the dark ages is without parallel in any other epoch in the civilized world's history.

Without any power over the forces of nature which were as yet unknown and therefore unused, with no solace from learning or comfort from art, without books or printing, without sunlight in his dwelling, the man of the dark ages knew no past, looked forward to no future and had nothing but toil in the dead present.

The monk had access to such manuscripts as the Goths had overlooked; he knew of a past, although it was a dead one; he was at least a member of the church universal outside of which there was no literature, no art, no society. But even to the most learned churchman, Greece and Rome were little more than traditions; the classic past had no message for him; Greece had worshipped his God as the Unknown, and Rome had crucified the Salvator Hominum. The culture of the pre-Christian republics and empires were nothing to him; its exponents had magnified the dignity of the human mind and had glorified, in stone and pigment, the beauty and strength of the human form;

but he read in his Bible: "I will bring to naught the wisdom of this world that no flesh may glory", and as regards the body, he was told it had to be "kept under" and mortified daily. The sincere man of the dark ages fasted when his Pagan precursor would have feasted; he despised natural beauty and endowments as being of the world or of Devil, his body was only an encumbrance to the life of holiness. Nothing was to be enjoyed; women were to be shunned in proportion as they were beautiful; with eyes bent on the ground, the monk saw no grandeur in the mountains, no gold in the sunshine, no glory in the flower of the grass. If such was the mental attitude of the sincere priest, what was that of the unworthy! He said "Hocus Pocus" instead of "Hoc est corpus meum", for, as he did not understand the Latin himself, he knew the people would be none the wiser. If culture meant a knowledge of the Pagan past, it was unattainable, for the literature of that past was nearly all lost; and such classics as were known were regarded as superfluous or impure. This most deplorable state of matters was practically ended by the invention of printing. By the middle

of the fifteenth century, the light began to burst at Haarlem, at Maintz, at Westminster, and once the instrument for obtaining knowledge was in men's hands the knowledge soon came. The knowledge that came first was knowledge of the lost past, it came through Italy and is called the Renaissance. At the fall of Rome, culture was routed; at the fall of Constantinople, culture was restored. When Constantinople was captured by the Turks in 1453, her scholars fled to Italy, bringing with them their precious treasures, the manuscripts of the classical authors. These learned men found patrons in the merchant princes of Florence, in the Medici, in the dukes of Tuscany, Modena, Parma and Ferrara. Their patronage was magnificent; culture flourished as it has never done since. In a short time numbers of scholars were copying, translating, printing, annotating and editing all the lost treasures of the mighty minds of Athens and of Rome.

When the printing presses of Venice, Florence, Strasburg, Antwerp, and London were working by the middle of the fifteenth century, the dawn of our day of culture had broken. The classical knowledge came to

England through Italy ; and affected Oxford, Cambridge, the court, the nobility and the public schools in the order named.

Now before we can go any farther, we find ourselves face to face with the word " classical ", and its relative classic and the classics. The origin of the word " classical " as supremely good, the best of its kind, worthy to live for ever, which it does mean, dates back to the political economy of Rome. Roman citizens for certain purposes were arranged according to their incomes in several classes. This led one to speak of a man in the third or the second or in the first or highest class, as the case might be. A man in the highest was simply classicus, classed pre-eminently ; " classy ", as the modern slang goes. We have a similar usage when we say, " a man of rank ", meaning of the highest rank. Persons in the highest rank were classici. By an easy transition of ideas, the writings of Greeks and Romans considered the very best of their kind, were called classical or " the classics " an extension which in time included all Greek and Latin literature.

The present point is that this humanistic influence was through the medium of

Italian literature, and I hold that through the vernacular of England to-day there can be the diffusion of that same humanizing culture. We need hardly be reminded at such an epoch as this how the term "humanism" arose, yet it is full of significance to us. The study of the classical past was found to have so fine, so broadening, so amelioring an effect on the mind that it was said to *humanize*. The contrast was with the effects of the ignorance of the Dark Ages which might be truly said to brutalize. Thus, chairs of Latin founded in the universities at this time were spoken of as chairs of "humanity", and a study of the classical languages was named that of the "Litteræ humaniores". Now I hold that without a specialist's knowledge of Greek or Latin, the English-speaking youth of to-day may be led into the appreciation of much that those ancient civilizations meant, and be made to feel that humanizing power by a wisely chosen course of study in English literature.

Without over-much philogical learning, it is possible to be made to appreciate through the medium of our own magnificent literature a very great deal that is characteristic,

essential and best in the life of the pre-Christian communities.

By English reading alone, a boy would be able to explain what was meant by " the music of the spheres ", " a sop to Cerberus ", who were the Graces, the Fates, and the Muses, where were Scylla and Charybdis, where were the Augean stables, the difference between Pandarus and Pandora, and be in a position not to confuse Plato and Pluto ; Plutus and Plautus.

The average boy is so busy with the mechanical drudgery of memorizing paradigms in grammar, that he can come out of it all quite insensible to the grandeur, the breadth, the robustness and the subtlety of classical thought. He may have spent years on Latin prose-composition, and yet be unable to tell you what " candidate " has to do with white, why a mausoleum is so called, why a certain kind of smile is known as sardonic or a countenance saturnine, what the Pierian spring has to do with learning, why dwarfs may be called pygmies, and finally what are the origins of Spartan, laconic, stentorian, tantalizing and ammonia.

Just as the English schoolboy, fresh from

the French class, cannot order his ticket or his lunch at Calais, so the grammar-grinder can go through the gorgeous galleries of Paris, Florence, Naples, and Rome and not be able to tell you anything about the Nike Aptera, Niobe and her children, the Coliseum or the Mamertine dungeon. Europe without humanistic culture is a wilderness; but in the English language we may find Europe completely described. The bricklayer can be so busy laying bricks that he is quite unconscious of the beauty of the palace he is helping to build. "The man with the muck-rake" never saw the crown.

It is possible to be a classical grammarian and yet a perfect barbarian at the same time. I am, however, not blaming the boys; when they take months to read a few chapters of Cæsar or Livy, how *can* they acquire a wide general knowledge of the characteristics of life in classical times? But what their class-books cannot give them, English authors can. It would not be difficult to draw up a course of reading to include classical history and biography, an introduction to the study of Greek and Roman customs, beliefs, laws and modes of thought. The past could then be made to *live* as it does live in English

literature, and as it does *not* in the class-books.

Some foundation in Greek and Latin grammar *must* be laid in order to comprehend the very rudiments of English etymology; but this being laid, a most fair superstructure could be erected of materials entirely derived from English sources.

Every phase of classical life has been expounded, from "Blackwood's Ancient Classics for English Readers" upwards by the most learned of English authors. There is no topic in antiquity on which some English treatise cannot be obtained; but better get knowledge from Baedeker's Handbook than not get it at all (though I would not be understood as regarding Baedeker as literature; its usefulness to students of literature seems to me to have been unduly neglected. The same applies even to the familiar Gazetteer).

Professor Gilbert Murray put the position so well once in an address to the imperial conference of teachers in London that one cannot do better than refer to his speech.

Professor Murray just doubted whether the boys were getting from their classical teachers that food to develop their minds such as a study

of botany or of English literature could give them. I frankly doubt it. English scholarship has laboured to expound classical life and conditions, and why should we ignore all this natural aid to a study of these very times. If we are " heirs of all the ages ", let us not hesitate to enter into our inheritance. Without this, a very great deal of Dryden, Milton, Keats, Shelley and Tennyson is lost on us. Without a knowledge of classic customs, practices and traditions, a very great deal of the New Testament loses its meaning. " I appeal unto Cæsar " ; which Cæsar, and to what sort of appeal was Paul alluding ?

European travel should, if possible, be indulged in, since the museums and many of the cities of Europe are so many object-lessons in antiquity ; the laboratories of culture, as it were. Instead of presenting so many libraries, Mr Carnegie might have instituted a fund to enable poor people, in search of that which interests the cultured, to travel in classical lands ; a fund for students and teachers and professors.

What a fascinating course of reading about the classics in English literature could be drawn up. It would certainly include Macaulay's " Lays of Ancient Rome ".

The Lay of Horatius, for example, might be read, and the boys made to explain the allusions.

> "But hark the cry is Astur!
> And lo the ranks divide;
> And the great Lord of Luna
> Comes with his stately stride;
> Upon his ample shoulders,
> Clangs loud the four-fold shield,
> And in his hand he shakes the brand
> Which none save he can wield."

And the boy might profitably be asked what slip in English grammar there is in the last line, even though it was written by Macaulay.

I should also include in that course of English literature the whole of "Childe Harold", partly on account of the exquisite stanzas that deal with the scenery of Greece and Italy.

The man that wrote that—brilliant, wayward, wandering Byron, whatever else he had or had not, had humanistic culture, and from his writings alone much of it could enter into the soul.

While I should be the very last person formally to sanction the omission of a study of the Greek and Latin languages in the case of certain young people, still I have never

held that in the case of some minds it was a necessary discipline. There are some third-rate minds which will never absorb culture of any kind, and to try to impart even the elements of classical knowledge to them would be a serious waste of their and their teacher's time. I believe in orders of mind, first, second, third and *n*th class; and I believe, further, that these mental endowments are as distinctly inherited as are peculiarities of body. But for some persons the study of the ancient languages is inappropriate. It is, however, impossible too soon to attempt to arouse in the mind of any boy or girl a love of the best in any literature but particularly English, a love of the sublime and beautiful in English writers, and the cultivation of the judgment to discriminate between the ephemeral and the immortal. For, after all, it does not need extensive erudition to perceive what are the limitations of humanistic literature at its best; we cannot forget that it lacks those features which are pre-eminently of Christian origin. The Roman had no sympathy with the weak, he was often entirely lacking in what Matthew Arnold called "sweet reasonableness"; the idea of toleration, which

is of the essence of culture, he scouted as folly, scenery in itself seems to have appealed to him very feebly, and, as for science, he knew none to admire.

English literature is so intrinsically important, so catholic in the range of its interests, so varied in its styles, and modes, contains so much that has been epoch-making, that we consider it a disgrace when foreigners are ignorant of its masterpieces ; how much more then the scandal when the sons and daughters of England do not know it, for to know it is to love it.

The literature that contains the English Bible, the Pilgrim's Progress, the works known as those of Shakespeare, the Principia, the account of the discovery of the circulation of the blood, the Essays of Lord Macaulay, Ivanhoe, The Heart of Midlothian, Adam Bede, the writings of Bacon, Paradise Lost, The Elegy in a Country Churchyard, and In Memoriam contains such masterpieces that the finest minds amongst foreign nations have called them classics ; there is no higher praise.

I am convinced that the reading of the English masterpieces is far too little made a matter of the ordinary, every-day school

routine. It is quite as important for me to know who said and under what circumstances it was said: "I would rather have written that poem than taken Quebec" ("The Curfew Tolls the Knell of Parting Day") as it is for me to extract the cube root of 1912. Oh yes! "the pen *is* mightier than the sword".

It may be of more consequence for me to understand the state of England politically, morally and scientifically during the lifetime of Shakespeare or Harvey, than for me to be able to define the cosine of an angle or to explain the meaning of negative indices, for—to quote a passage which has already appeared in this volume in another connection—

> "These earthly godfathers of heaven's lights,
> That give a name to every fixed star,
> Have no more profit of their shining nights,
> Than those that walk and know not what they are."

English literature, while as subtle as the Greek and virile as the Roman, can give a culture sweeter, fairer, more human, *more humanistic*, for it gives us something which neither proud philosophy nor clear-eyed science knows, and which the most finished

product of antiquity could never have felt. It has tenderer songs and more delicate fancies than the finest of the ancients could have sung or dreamed; "Daffodils that come before the swallow dares, and take the winds of March with beauty", could never have been written out of England.

English culture includes a tolerance which the Roman would have scorned as weakness, a capacity for admiration which his pride would never have permitted, and a humility of spirit which constrains us to believe it is perfectly true that, "to know all is to forgive all".

X

THE INFLUENCE OF ITALY ON BRITISH LIFE AND THOUGHT

To many persons it would seem either frivolous or satirical to speak at the present time of the influence of Italy on Great Britain, whether by influence we mean either a political or an intellectual one. If we except musical compositions, then in the estimation of most people it would seem that waiters, marble angels, table-tops, street pianolas, ice creams, products for Italian warehousemen and certain modes of cooking would comprise the contributions to English life emanating to-day from that fascinating peninsula. But we are not thinking of to-day. The truth is that many of us are scarcely at all aware of the very great influence which Italy exerted on the intellectual life, not only of England but of the rest of Europe in the fifteenth and sixteenth centuries, an influence

whose effects are still clearly traceable in almost every phase of life north of the Alps.

The Renaissance, though a movement which originated in Italy, could not be confined to that great meeting-place of East and West. It was quite impossible that the energy of a movement, which in the land of its birth had in one way or another permanently altered the aspect of every phase of Italian life, could be restricted within the geographical limits of a country in which the agents of the merchants of London met those of Constantinople on that unique common waterway, the Grand Canal. It was inevitable that Italy, then leading the world into the enjoyment of all in literature, art and science that the New Learning had to reveal, should have profoundly influenced even so distant a country as the island England, which although it had indeed slept through the night of the Dark Ages, had never been quite unconscious of certain notable phases of activity whose theatre was outside itself. The Crusades and later the Reformation had not been without influence on the intellectual life and secular thought of England.

But of course it is a sober fact that the

Christian religion reached England through Augustin sent by Pope Gregory the Great direct from Rome in 590 A.D.

As Italy reached her intellectual zenith when England was just awaking from her sleep, so England, having learned a great deal from Italy and borrowed much that was best there, carried on the spirit of the Renaissance at least in science and in medicine long after the sun of Italian glory had begun to set. As in commerce, Venice had been the world's exchange when London was merely England's, so London was to be the world's vast meeting place when Venice had become an architectural museum and an exhibition of pictures, a collection of magnificent relics sinking in sad splendour to their grave in the Adriatic slime. The call of Italy has always had a great fascination for the best minds ; Milton heard it and never forgot the autumn leaves of Vallombrosa ; Addison obeyed it and was inspired to create the famous phrase " classic ground " ; while meditative Gray sent from Italy some of the best letters he ever wrote.

As in physical science the Italian Galileo had led, the English Newton, following, had universalized ; so too in medicine, the

university of Salernum was training surgeons and granting them academic licenses and diplomas at a time when surgery in England was the affair of barbers and wig-makers. The English youth William Harvey in the first year of the seventeenth century was already far ahead of his septuagenarian instructors in Padua. So in the eighteenth century, when the Hunters of the London School of Anatomy and the Monros of the Edinburgh were discovering what was to stand the severest test of time, little was being contributed from Padua or Bologna towards those very subjects, Clinical Medicine and Pathology, which had had their origin in these southern universities. But it is equally true that when our forefathers in England were woad-stained savages, the highly civilized Etruscans were adorning vases and performing with an admirable technique such operations in dentistry as bridge-making in gold.

Most of us have no adequate notion of the magnitude of our indebtedness to Italy—for instance, in the handling of merchandise and all manner of trading—yet our every-day language is full of testimonies to it. Do not £ s. d. stand for liri (*livri*), soldi,

denari, although we call them pounds, shillings and pence? "Bank" and "bankrupt" are banco and bancorotto, the banco being the bench or banc at which the banker sat to transact his business. Our "journal" is but giornale or that which came out every day (*diurnal*). Our word "gazette" takes us back to the time when a single sheet of news in hand-writing was displayed in a certain place in Venice, where each person had to pay a small coin or gazetta to read it. Again the word "policy", as in insurance policy, has nothing to do with policy in the ordinary sense of that word; it comes from polizza, a promise. Our word "quarantine" has no connection in itself with any disease, it is the Italian quaranti from the Latin quadraginta or forty, the forty days' detention which a plague-stricken ship underwent in the port of Venice. The very form of the word "company" on the notes of the Bank of England at the present day is an Italian and not an English form at all (*Compa*). What, for instance, do we mean by *Italics* in our printing? Nothing other than the use of a certain sloping type first used in Italy. And where did we get that sloping handwriting, the beautiful copper-

plate caligraphy of our grandfathers? From Italy; it is sometimes called the Spencerian; it is really a copy of Petrarch's own handwriting and it came to Britain from Italy in the sixteenth century as one of the minor results of Italian influences on us at the Renaissance.

To those of us who know Lucca at the present time, it is almost ludicrous to think of such a place lending an English king, our Richard I, funds wherewith to meet his part of the expenses of the Crusades. Not only was there much commercial reciprocity between England and Italy in the fourteenth and fifteenth centuries, but the galleys of Genoa and of Venice carried more merchandise to and from the shores of England than did all the English ships taken together. Italy taught England how to trade, she has certainly bettered the instruction. Villani, the Italian historian, tells us that the two great Florentine families of the Bardi and the Peruzzi lent King Edward III more than one million ducats, and that when at last these two great financial houses became insolvent, the failure disturbed the whole of Christendom.

But how comes it that every pawnbroker

displays the sign of the three balls over his door? These three balls (*palle*) were the arms or crest of the world famous family, the Medici, and you can still see them emblazoned in unfaded colours on the roof of the cathedral at Pisa. Now the Medici, besides being the virtual rulers of Florence, were the greatest bankers in Europe, and so it came to pass that their family arms were adopted as a sign by those who carried on transactions more or less analogous to legitimate banking. Every one knows that the name Lombard Street in the city of London dates back to the time when the merchants of Lombardy dominated English business.

As early as the middle of the fourteenth century, when the Duke of Clarence, son of Edward III, married Violanti, daughter of Galeazzo Visconti, Lord of Milan, London consisted of unpaved streets and thatched houses in which people slept on beds of straw. The contrast with the city of his bride must have been very great. Smoothly paved streets were flanked by lofty palaces of marble, in one of which the wedding feast took place amid every sign of luxury and splendour. Presents were given to the two

hundred Englishmen of the Duke's train, and the occasion was made memorable, not only by the profusion of rare dishes, but on account of the display of suits of wrought armour, coats embroidered with pearls, jewels set in gold on the belts and gold lace over crimson cloth. The greatest poet of his age, Petrarch, sat amongst the Princes at the feast, the remnants of which could have fed thousands of people. Such was the scale of magnificence in Italy when in England, wine, for instance, was being sold like a medicine.

It is not very widely known that the art of printing did not arrive in England, until twelve years after it had been practised in Italy. When at the close of the fifteenth century there were printing-presses in seventy-one Italian cities, England had them in four of hers.

Ornamentation on the bindings of books, (gold tooling) was, in Europe, first seen in Italy; it had come there from the East.

It is a commonplace of knowledge that art in Italy was magnificent when elsewhere it was scarcely born; and long afterwards, when France, Germany and the Netherlands had each a school of painting, the

education of no artist was deemed complete until he had stretched his canvas under the Italian's sunny sky. But what is true of painting, is equally so of the allied arts of sculpture, architecture and house-decoration in stone, metal, wood and plaster. Some of the choicest bits of ecclesiastical architecture in England—Henry VII's chapel in Westminster Abbey and King's College, Cambridge—are not native work at all but Italian, while the most beautiful plaster mouldings on the ceilings of many English and Scottish mansions, of Holyrood Palace to name only one, were fashioned and fixed there by Italian hands. An Italian garden was at one time the type on which all good English gardens had to be modelled; the terraces, grottoes, statues and vases being of transalpine origin.

In music of a certain kind, Italy has always been *facile princeps*. The Italian opera, until the rise of the Wagnerian, was the paragon of operas; and if Italian music is not at the present moment so omnipotent a power in the art world as it once was, we have to remember that it has influenced the style of numbers of foreign composers, amongst them the mightiest

tone-poets of France, Germany and Austria.

The amount of Italian influence on English life in the spheres of diplomacy and statecraft was very great; it was in these as part of general culture that the training of the gentleman of the Renaissance was to consist. The courtier was the highest product of all the co-operant tendencies of the Renaissance; its learning, its poetry, its interest in revived antiquity, its polish, its technical knowledge of art, and its skill in all manly outdoor exercises were to be his. The exquisite result embodied in a Sir Philip Sydney or a Sir Walter Raleigh was quite Italian, and very directly due to humanistic influences. The very comprehensive culture of the Admirable Crichton of St. Andrew's, for instance, including as it did, not only the knowledge of foreign languages, but also philosophy and classical archæology, was typically Italian in its splendid catholicity, and women as well as men came under its power. As excellent examples of such ladies we might take Vittoria Colonna and Isabella d'Este, the patron of Aldus Manutius, the Venetian printer, who was printing as early as 1476 those beautiful editions of the Greek classics

which have survived to this day as exquisite examples of his art. Equally humanistic and therefore of Italian origin was the learning acquired by Queen Elizabeth, Lady Jane Grey, the Countess of Bedford, the Countess of Pembroke, the mother of Francis Bacon and Mary Queen of Scots. This enthusiasm for learning for its own sake, though scarcely so widespread in England as in Italy, yet deeply and fruitfully affected the best English minds.

In the matter of biblical criticism one tends to look farther north than Italy; and certainly the humanistic ruler at the Vatican who spoke of "this fable of Jesus" was at the spiritual antipodes from the monk at Worms; nevertheless alike in piety and erudition Peter Martyr Vermigli of Florence and Bernadino Ochino of Sienna were not a whit behind their Teutonic brethren. Both resided in England, the writings of both were translated into English, and the former occupied a Chair of Divinity at the University of Oxford. Of Peter Martyr, the discriminating Beza said: "He is a phœnix born from the ashes of Savonarola".

Turning now to Literature, nearly every one knows that the influence of Italy on our poetic and dramatic literature was of the

deepest. The Italian novels (*novelle*) and the writings of Boccaccio in particular, supplied the subject-matter of a great deal of the lighter literature of England during the fifteenth and sixteenth centuries. The setting and scenery it is said of fourteen of the plays of Shakespeare is pure Italian; so noticeable is this that the suggestion has seriously been made that Shakespeare must have travelled in Venetia. Not that our and the world's greatest dramatist was the feeble borrower of ideas from obscure Italian tale writers. Shakespeare used Italian scenes, plots and dramatic situations to supplement what was lacking in the picturesque in the life of England. He used these foreign raw materials in working up by means of the transfiguring power of his own genius that which was to be for all men, everywhere for all time. He borrowed, if you will, but he borrowed Italian bricks to hand them back to the world as marble. To the mint of his mind was brought base foreign metal, the great master issued it pure English gold with the stamp of the eternal on it. We should be more exact in speaking of Italian materials for Shakespeare rather than Italian influences on Shakespeare, for no one country or time

could influence him who was to influence all for ever. There were Italian actors established in England before there were any English ones.

On many of Shakespeare's poetical predecessors the power of a very potent spell was cast by Italian poets and especially by Petrarch, whose sonnets became for many a day the model for English poets to copy, until some of their sonnets were little more than translations of his. Sir Thomas Wyatt, Henry, Earl of Surrey, Sir Philip Sydney and even Shakespeare himself in some of the sonnets were all more or less consciously imitating Petrarchian mannerisms. It may even be said that they were plagiarizing, but plagiarism was not in the fifteenth or sixteenth century that deadly literary sin that it is in the twentieth.

The Italian influence on English literature was at its height during the reign of Elizabeth at a time when the national spirit was rapidly maturing towards a robust patriotism. Indeed it was the successes of the Italian circumnavigators, notably of Christopher Columbus of Genoa and of Amerigo Vespucci of Florence that fired the latent enthusiasm of Elizabeth's hardy seamen. It is certain that

the geographers of Italy had charts and maps of the world as they knew it many years before any other nation. For two hundred years before the reign of Henry VII, Italian ships had carried nearly all England's merchandize ; and our earliest books of travel are but translations of Italian works published during the period of the Renaissance. The classical Renaissance in Italy meant a great deal more than a study of the Latin and Greek tongues and the ability to write in those languages, a relic of which is, of course, still with us in the Public Schools' insistence on the writing of what is called Latin and Greek " verse ". It meant for all persons desirous of being thought educated, a degree of acquaintanceship with matters relating to classical antiquity not even attempted to be attained in this day save by professional scholars. The medical man of the Renaissance was a scholar. Linacre, physician to Henry VII and Henry VIII and the founder of the Royal College of Physicians, was a great deal more than an Oxford graduate in medicine. Thomas Linacre and John Chamber, his brother physician to Henry VIII, had both studied medicine at Padua, of which, at that time great university, they were doctors of

their faculty. Linacre, along with the erudite Grocyn, had as their pupils at Oxford students who were afterwards to be known to the world as Sir Thomas More, Dean Colet, Cardinal Pole and the mighty Erasmus himself. Oxford was the first place in England to feel the influence of Italy; the order of subsequent reception being Cambridge, the Court, the Nobility and the Public Schools.

We are indebted to Italy for the models of two out of the four Scottish universities, and for much else that is characteristic of academic life in Scotland. By 1065, a year before the Norman conquest, there was established at Salernum a studium generale to which flocked students not only from all parts of Italy but also from France and Germany. Petrarch called it "Fons Medicinæ". By 1096 its reputation as a school of surgery was such that Robert, Duke of Normandy, a brother of the Conqueror, returning from the Crusades, halted at Salernum to have his wounds professionally treated. Thus about 600 years before Surgery was an academic subject in England, it had its professors and its practice in what is now an unimportant town on the shores of the Mediterranean. There was a faculty of Arts also, for the

students of Medicine were required to study Arts for three years before giving no less than five to the study of Medicine, not a bad curriculum for the eleventh century!

By 1088 this great University of Salernum had added to it a faculty of Law, and it continued to be the most celebrated school of Law until, on its decline, the centre of medical gravity was transferred to the northern city of Bologna. In Bologna the study of Medicine and Surgery flourished greatly, wholly due to the insistence of its professors on the dissection of the human body. The University of Bologna is interesting to us because it was explicitly on it as a model, that the Renaissance Pope, Nicholas V, founded the University of Glasgow in 1450. Architecturally the original University buildings were Renaissance in their design; the stones fortunately remain in their relative positions and constitute the gateway of the beautiful new University buildings in the west of Glasgow. Glasgow then, academically, was a daughter of Bologna. Another Pope—a man very different from the book-loving Nicholas—I mean Alexander VI, founded in 1500 the third university of Scotland that owes its existence to foreign influence—Aberdeen. It was the

Spaniard, Alexander Borgia, who was instrumental under good advice in founding a seat of learning in the then wild and bleak country of the north of Scotland. The University of St Andrews had been founded in 1411 by Benedict XIII (Peter de Luna) the anti-Pope at Avignon.

Since Oxford owed its existence to Paris, and no less than three out of the four Scottish universities were created by foreign influence, we see what was the indebtedness of the world of British learning to forces moulding it from afar.

The next feature of our intellectual life which came to us very directly from Italian sources was the learned society or academy. Our own Royal Society dates only from the middle of the seventeenth century, and did not get its charter from Charles II until 1662. But all the learned societies of Europe were modelled on the type of that at Florence, the Florentine academy, founded by Cosimo de Medici before 1485. When England was being riven by the wars of the rival roses, the Florentine savants were discussing the importance of the study of Greek in general, and of Plato in particular, in an atmosphere of intensest enthusiasm for learning of every kind.

To return to the court of Henry VIII, it was, in a word, Italianated, for besides the two Englishmen, Linacre and Chamber, both of them Italian trained, Henry had two other physicians who were Italian born, Battista de Boeria and Ferdinando de Vittoria. We are not at all surprised to know that the court surgeon was also an Italian, Antonio Ciabo. Another at the same court, Ammonio, a personal friend of Linacre, knew the great Erasmus well; while still another Italian, Petruchio Ubaldini, served in Henry VIII's unjustifiable and devastating war against Scotland. Adrian de Castello, at this time papal Nuncio for Scotland, wrote a Latin poem published by the world-renowned Venetian, Aldus, who was also Linacre's publisher. Corneliano, another Italian, wrote a Latin poem on the death of James IV at Flodden having so many false quantities that Erasmus derived immense amusement from it.

In the next reign, Peter Martyr Vermigli, after eight years' study at Padua, was invited by Cranmer to come to teach at Oxford, and the unfortunate philosopher, Giordano Bruno spent two years (1583-1585) at the court of Elizabeth. Bruno lectured at Oxford as a neo-Platonist on the immortality of the soul;

in physical science he expounded the Copernican philosophy then described as new. Bruno's publisher in England was that same Thomas Vautrollier who spent seven years in Edinburgh (1580-87), and published no less known a work than Knox's "History of the Reformation in Scotland". Jacopo Acontio, an Italian living in England at this time, wrote a treatise on the philosophy of History, in which he demonstrated the influence of the environment on the individual, and exhibited man as the product of his age. So well-known an Englishman as Thomas Cromwell had studied at Padua, where you may still see his coat-of-arms on the wall of the cortile; Padua had sheltered John Panketh as well as Sir John Cheke, who had lectured there and had counted amongst his friends that strange man of universal learning—Jerome Cardan (Hieronymus Cardanus).

The links between Oxford and Italy were neither few nor unimportant. Henry Chicheley, the founder of All Souls and the giver of gifts to Oxford, had long resided at Sienna; Alberico Gentile, who had come to England in 1580, was seven years later appointed regius professor of Civil Law in England's premier university. Richard Croke, the friend of More

and Linacre, had studied in Italy; Thomas Starkey of Magdalen College, one of the lecturers at Oxford, had been at Padua; while Robert Parsons of Balliol had studied Medicine in the same halls. This great university of north Italy had been Alma Mater to such different Englishmen as Peter Courtney, later Bishop of Exeter; Richard Pace and Sir Thomas Hoby. To Pace, Erasmus addressed more letters than to any other of his learned friends.

Many were the Englishmen who, though not matriculated at any Italian seat of learning, yet travelled through the country to enrich their minds; of such were the elder Sir Thomas Wyatt, Inigo Jones the architect, and John Dowland the musican. But at all times the call of Italy has been clear to artist, scholar and antiquary. Occasionally one of our countrymen attained to high honours in his adopted land; we cannot forget how Crichton held his own in learned disputations against all-comers on the continent, and how Peter Bisset, a graduate of St Andrews, died Professor of Canon Law at Bologna. On the other hand, Erasmus, the prince of humanists, did not at first go to Italy, but to Oxford to study Greek, his reason being that all that Oxford possessed

of classical learning she had derived from Italy, and that this in Oxford had gone on to a quite independent growth. But it was at Cambridge, as we all know, that the Italian model was most closely followed in the re-foundation of Gonville Hall by John Keys, M.D. (Johannes Caius), a man as deeply versed in humanistic lore as any of the others who had left Oxford for Italy, a man who had not only studied Medicine at Padua, but had remained there for some time to lecture on Greek. There seems little doubt about the correctness of the statement that Caius at Padua lodged under the same roof as the great Vesalius. If Caius studied Medicine at Padua, then the father of modern anatomy must have been one of his teachers. The college which Caius founded at Cambridge was from the first intended to be a medical one, and both in constitution and architecture it was on an Italian model. Its gates of Humility, Virtue and Honour are in the florid style of the Renaissance. Caius stipulated that the holders of its travelling medical scholarships should study either at Padua, Bologna, Montepulciano or Paris. But in constituting thus this characteristically medical college, he introduced into England the

study of practical anatomy, that is, the dissection of the human corpse, the basis of all surgery and the practice of the medical art. An original member of the College of Physicians, Caius may certainly be regarded as one of those who "laid truly and well" the foundation-stones of English medicine, and if that is so, it is evident that it drew its inspiration and was given the leading lines of its activity very directly from Italian sources.

Possibly few know that when Francis I in 1542 wished to establish the school of Medicine in the Collège de France, he sent to Florence for Guido Guidi (Vidus Vidius). Guidi did his work of organization so efficiently that when he resigned in 1548 and went back to Italy, the wits exclaimed: "Vidus venit, Vidus vidit, Vidus vicit". His name remains with us to this day in the "Vidian nerve".

However ready the well-informed person may be to admit that Italy led the way for Europe to follow in classical learning, in fine arts and architecture, in poetical and other literature, in diplomacy, statecraft, circumnavigation and cosmography, yet the statement that she also as distinctly led in the physical and biological sciences would scarcely be so readily assented to. One instinctively

thinks of the Italy of a past day, poor and disunited, the most unlikely country to lead in anything anywhere, least of all in science the British Empire. But we should think of the Italy of the Medici in their zenith, a time when there was no United Italy and no British Empire; both are recent, the one a synthesis, the other an evolution. The Italy of the Renaissance was indeed geographically many states, but their courts vied with one another in the passionate love of culture and of what science there was and in extending patronage to men of letters and to men of science. English science had not been born, it was barely conceived. Roger Bacon was indeed an Englishman, but he was of the thirteenth century, a prophetic voice calling unheeded but not unpersecuted in a desert of theological bigotry and intellectual vacuity. England was a nation, but of shopkeepers and sailors; she had men of commerce, men that went "down to the sea in ships", men that did "business in great waters", and men of letters too, but as yet no men of exact knowledge.

Was not one of the first stars ever seen through a telescope seen from the summit of the campanile at Venice by one of Galileo's

"optical tubes"? Was it not the swinging of that candelabra in Pisa's cathedral that, viewed by Galileo, brought all the pendulums of Europe into being? Was it not from Pisa's leaning tower that ocular demonstration was made, once more by Galileo, to the Senate of the University to the effect that as regards the laws of falling bodies the æon-revered Aristotle was absolutely in error? Did not Galileo devise the thermometer? Was it not on the roof of a house in Bologna that the first scientific observation was made by Galvani, as every one knows, in regard to electricity, concerning which form of energy we know not whether to admire its adaptability to our uses or to wonder at its mysteriousness? Was it not at Padua that the revelation came to the young English student, William Harvey, as he watched the Italian dissecting the venous valves—the revelation of the ever-moving blood; and was it not again an Italian, once more in Bologna, who, first of all men, realizing what he saw in the light of what Harvey had taught, beheld through his microscope the living blood moving as Harvey had said it must.

The eye of an Italian was the first to gaze

on a star through the space-annihilating telescope—the eye of an Italian was the first to behold the innermost recesses of life through the space-creating microscope—sufficient leading this in astronomy, physics and biology.

Her own sons to-day admit as just the description of Italy as the "land of the dead"; but the Italy of the past might with equal justice be described as, intellectually, the land of the first-born.

XI

THE CENTENARY OF HUXLEY

When Louis XIV was asked what the State was, he replied: "I am the State". Of Huxley we might say that he was the science of the nineteenth century. In the popular mind he was the type and representative of the science of the Victorian era, and the popular mind was quite right. In the opinion of many religious and "Christian" people he was regarded as not far removed from Anti-Christ. With the name Huxley will ever be associated the names of Darwin and Tyndall in a kind of unholy alliance. Multitudes of people, who have only the vaguest idea of the facts which these men studied for a lifetime, will continue to regard the three great Victorians only as critics of Biblical tradition, and as the protagonists of some modern horror called "Agnosticism".

* * *

The nineteenth century was but twenty-five years old when Thomas Henry Huxley was born in the quiet country village of Ealing—the son of a schoolmaster, George Huxley, of whose seven children Thomas was the youngest surviving. Two sisters having married practitioners of medicine, he devoted his mind to that profession, so that in 1841 he became apprenticed to his brother-in-law, Dr Chandler, at Rotherhithe in the East of London. Here, amongst the population of the docks, he saw such scenes of squalor, drunkenness and vice as haunted him all his life, and made him determined to do something beyond what is called "philanthropic" for the working men of England. In later life, his lectures to working men became famous all over the world.

Changing his abode to the house of another brother-in-law, Dr Scott, in North London, Huxley began to read for the matriculation examination of London University. On October 1st, 1842, he entered upon his course of medical study at Charing Cross Hospital. Here he came under the influence of Dr Wharton Jones, the lecturer on physiology, of whom he afterwards wrote: "I do not

know that I have ever felt so much respect for anybody as a teacher, before or since". Even at this early date Huxley was a constant worker with the microscope, and to such purpose that Wharton Jones advised him to publish a paper describing the existence of a layer of cells in the human hair-sheath which had not previously been recognized. Jones himself revised the paper, so that his promising pupil might appear with credit in the *Medical Gazette* for 1845. The pupil showed his practical gratitude long afterwards by helping to obtain a pension for his old teacher.

Huxley graduated M.B. (London) in 1845, winning the gold medal for anatomy and physiology, but soon found—as so many have found before and since—that a degree by itself is no provider of bread and butter. A friend advised him to apply for an assistant-surgeonship in the Royal Navy, which he obtained with very little trouble. In October, 1846, he was gazetted to H.M.S. *Rattlesnake*, 26 guns, Commander, Captain Owen Stanley. This old frigate was commissioned for a voyage of scientific exploration in the waters between the coast and the great barrier-reef of Australia. Here and in other tropical

seas she spent four years. Huxley was to be the naturalist to this expedition; soundings were to be taken and dredgings carried out. While waiting to sail, he attended his first meeting of the British Association (1846)—an assembly over which he was one day to preside, for at Southampton he read his first paper on "The Blood of Amphioxus".

Although he was given a place for his microscope in the well-lighted chart-room of the *Rattlesnake*, he was not provided with any modern books of reference, nor does it appear that the scientific aspect of the cruise was unduly emphasized. When the materials were brought up in the dredge, it was found that there was no sieve wherewith to separate and wash the various "finds", so that the cook had to lend the scientists a meat-cover. From Madeira to Rio there was never less than one inch of water in Huxley's cabin; the men's quarters had no ventilation; cockroaches swarmed in their thousands; and as the best food was cocoa and "weevilly" biscuits, it is not surprising that they had two cases of scurvy on board. The officers, with the exception of the captain, regarded the young

naturalist with amusement and well-bred contempt, while every now and again the half-finished dissection of some soft-tissued marine creature would be flung overboard as a "mess". "The Service" is nothing if not tidy.

Two papers sent home to Professor Edward Forbes, the naturalist, were read before the Linnæan Society in 1849, and published in the name of "William" Huxley. As Forbes had failed to acknowledge the receipt of these papers or tell of their fate, Huxley was rather worried at having no news of them. He was to experience worries greater than these. By 1848 he sent home a paper "On the Anatomy and Affinities of the Family of the Medusæ", ready for presentation to the Royal Society. Of this also he heard nothing until his return in 1850.

Here and there he and his brother officers had stirring experiences, as when on one coast they landed to find that a party of white men had all been murdered except the one who told the tale. At some other benighted spot the chief hailed Huxley in an ecstasy of delight as the reincarnated spirit of his dead brother, not even the scientist's temporary red beard being sufficient to prove an alibi. Having an island

in the Louisiade archipelago named after him was scarcely a compensation for the continued absence of news about his precious papers.

On November 9th, 1850, the *Rattlesnake* was paid off at Chatham, where ended a voyage which did for Huxley what that of the *Erebus and Terror* did for Hooker and that of the *Beagle* did for Darwin—gave him the chance of interrogating Nature directly. Arrived in London, he soon found out that the Admiralty had no intention of keeping its promise to publish his memoirs, with all their twenty-five carefully drawn plates. The Royal Society, which had previously published his paper on the "Medusæ" in the *Transactions*, and which could vote money for research but not for the publication of it, sent him to the Prime Minister, who sent him to the Treasury. The Treasury sent him back to the Prime Minister, on what he felt was a fruitless errand. These inter-departmental delays fretted his eager spirit, until in November, 1851, he found himself at the age of twenty-six elected into the Royal Society. In the following year he was awarded the "Royal" medal, so that he discovered there was some balm in the scientific Gilead for the physician there.

In 1853 both he and Tyndall were rejected candidates for chairs at Toronto University, where the chair of zoology after two years' delay was filled by the election to it of the relative of an influential Canadian politician! Huxley was learning that if the path to the stars is strewn with roses, there are a good many thorns mixed with those fragrant flowers.

While he was still in a state of justifiable irritation at the pusillanimous postponements of the Treasury and the breach of promise by the Admiralty, he received an order to join his ship at Portsmouth under pain of being struck off the Navy list. Regarding this as adding insult to injury, he resigned his commission in March, 1854. But now that he had left the premier service, the Royal Society felt free to vote towards the publication of his memoirs the sum of £300. The collective title was "Oceanic Hydrozoa". Huxley, who was acting up to the family motto, *tenax propositi*, had a moral victory, but his worldly prospects were even worse than before. He was an unsuccessful candidate for chairs at the University of Aberdeen, Queen's College, Cork, and King's College, London.

Under these circumstances, he could think of nothing more feasible than to go out to Sydney and start medical practice in the city where was the girl he had left behind him. This lady was his fiancée, Miss Henrietta Heathorn, in whose father's house he had been the recipient of much hospitality when cruising with the *Rattlesnake*. While meditating this hegira to the Antipodes, he heard that he had been elected to a seat on the Council of the Royal Society, so that his scientific reputation was rising in inverse ratio to his income. Distinctions continued to be conferred upon him, for just at this time he was appointed to lecture before the Royal Institution—a very great honour for so young a man. Writing to his sister about it, he said: "It was the first lecture I had ever given in my life, and to what is considered the best audience in London". He was certainly beginning at the top. "After the Royal Institution", he told his sister, "there is no audience I shall ever fear". Nor did he. When we consider how successful he was as a writer and a speaker, it is certainly interesting to hear from himself that neither writing nor speaking came easily to him.

His time of waiting came to an end in July, 1854, when he obtained the post of Lecturer on Natural History at the Government School of Mines, Jermyn Street, with a salary of £200 a year—about one-fifth of what an hotel pays its chef. So little did the so-called "man in the street" realize the minuteness of the endowments for the teaching of science that, when some years later, one of the rich managers of the Royal Institution was asked to support Huxley's candidature for the Fullerian Professorship of Physiology, he said: "But what is the use of £100 to him? I give that to my butler".

The £200, however, removed a load of anxiety, and made it possible to think of marriage. Into that state of blessedness Huxley entered in 1855, having waited eight years for his bride. The chair which he then filled had been rendered vacant by the call of Edward Forbes to the chair of Natural History in Edinburgh. Forbes, always in delicate health, died within two years of his migration to the northern metropolis, and Huxley was invited to be his successor. With characteristic decision, he declined this offer, preferring to be a door-keeper on a

small salary in the house of science rather than to abide in the tents of Scottish learning on a much larger one. Cultured and critical Edinburgh was to hear him all in good time.

He had not long to wait for another honour for which some men twice his age had to wait fifteen or twenty years. Proposed by the geologist, Sir Roderick Murchison, he was elected in 1858, *nemine contradicente*, into that Holy of Holies, the Athenæum.

Between Christmas, 1857, and the New Year his first-born, a son, was christened Noel. Five years later, in the same study in which he had waited for the glad news of the birth, he beheld through a mist of tears the cold little body of the laughing golden-haired child who had been carried off within forty-eight hours by the microbic diabolism known on earth as scarlet fever. In that same room, four years before, he had recorded in his diary that his objects in life were these: "To smite all humbugs, however big; to give a nobler tone to science; to set an example of abstinence from petty personal controversies, and of toleration for everything but lying; to be indifferent as to whether the work is recognized as mine

or not so long as it is done,"—these were aims of the man whom thousands of canting pietists as well as thoughtful "believers" regarded as a veritable Man of Sin.

* * *

In 1859 Huxley attended the Aberdeen meeting of the British Association under the Presidency of Prince Albert; but 1859 is memorable for an event much greater than any meeting of the British Association for the Advancement of Science. On November 24th the firm of John Murray published a volume entitled "The Origin of Species by Means of Natural Selection", a book destined to arouse more controversy and ill-feeling than perhaps any other book, with the exception of the Bible.

The author, Charles Darwin, an English naturalist of private means who lived in all but complete seclusion at his country house of Downe in Kent, had made a study of the perplexing problem how the multitude of existing species of plants and animals had come into existence. It is not too much to say that the world of things of the mind has never been the same since

November, 1859. Why a scientific attempt to explain the origin of species should have produced nothing less than an intellectual earthquake, is not, of course, self-evident. That a book written in a dry style, and so full of close reasoning upon a multitude of facts about plants and animals, the very names of which the public had never heard, should have aroused such a storm of hostility, is however explicable enough. It developed a theory of becoming in regard to the human race which points unmistakably to the close kinship between human beings and the higher apes. This is but one of many conclusions reached in that monumental work. But it was the one on which the non-scientific public naturally fixed its attention, and which—for a variety of reasons—it strongly objected to believe.

The word "species" nowhere occurs in the old Hebrew account of the creation of man and other living things. It is thus only by a gratuitous assumption of species in the modern sense as referred to in Genesis that one is able to compare the Mosaic cosmogony with the Darwinian hypothesis at all. Charles Darwin was, of course, not the first evolutionist. But for one person

who had heard of Lamarck, ten thousand were to hear of Darwin, through Huxley.

In the Biblical narrative we have a poetically worded declaration that certain " kinds " of animals were called into existence in a perfect or adult state out of water or earth, by divine power, at some remote but entirely unknown date. So it was concluded that they have never varied in their characters since that time. If anything is taught which can be expressed in modern language, it would be the fixity or immutability of species ; but Darwin's whole treatise is designed to show that a species is not some fixed, immutable, unprogressive thing ; on the contrary, that innumerable links may be found between any two extremes selected for study in the realm of living beings. On the face of it, the *ex cathedra* account in Genesis *explained* nothing ; it gave a narrative of events that were said to have occurred once and for all in the history of the earth. The theory of organic evolution or becoming is at least an attempt to provide an intelligible explanation of *how* the myriad of living forms have come to present those characters which we now find them possessing. To comprehend Darwin's book, more

than a superficial acquaintance with zoological, palæontological and ethnological science is necessary—a prerequisite which, it is perfectly certain, not one per cent. of those who denounced its author as an "atheist" possessed.

The "Origin" did not come to Huxley, as it did to many others, like a bolt from the scientific blue. Along with Lyell and Hooker, he had been in Darwin's confidence regarding its main thesis. Huxley reviewed it in *The Times* for December 26th, 1859. It is difficult for us to-day, when we find the idea of evolution applied everywhere, from religious systems to æroplanes, to realize the intensity of the opposition aroused by the chief exponent of the Darwinian hypothesis. Both by clerics and by the laity, Huxley was denounced as a godless disturber of the theological peace.

Clerical opposition was brought to a vivid focus by Bishop Wilberforce, at the meeting of the British Association in Oxford in 1860. The occasion was one of the most memorable in Huxley's long controversial career. On Saturday, June 30th, Dr Draper of New York was to read a paper on "The Intellectual Development of Europe, con-

sidered with reference to the views of Mr Darwin". Huxley had not intended to be present at the Biological Section that morning. Greatly in need of a rest, he had intended joining a country-house party, when quite accidentally he met old Robert Chambers, the anonymous author of "Vestiges of Creation". On learning of Huxley's intention, Chambers begged him not to desert them, as it was rumoured that the clergy meant to turn out in force to support the bishop, whose eloquence in debate was well known.

One who was present has estimated that there were seven hundred persons in a room not designed to accommodate more than a fraction of that number. A great many were ladies, ready with their handkerchiefs to acclaim the champion of the Church. In irreverent circles the bishop was known as "Soapy Sam", for Samuel was his (Christian) name. The chairman, Professor Henslow the botanist, had beside him on the platform (in addition to the bishop and Huxley) Sir Joseph Hooker, Sir John Lubbock, Professor Beale of King's College, London, and Sir Benjamin Brodie.

Dr Draper droned on for about an hour.

Several speakers had followed him, when it was with a sigh of relief and anticipation that the audience welcomed the suave and gifted ecclesiastic. Wilberforce's speech has been described by one who heard it as fluent, florid, unfair and jejune. After half an hour of this sort of rhetoric, his Lordship turned to Professor Huxley and sneeringly asked him whether it was through his grandfather or his grandmother that he was descended from a monkey.

Huxley, perceiving in an instant that by descent to personalities his antagonist had gone outside the bounds of gentlemanly behaviour, turned to Sir Benjamin Brodie and whispered: "The Lord hath delivered him into my hands". Rising, pale and determined, he began in a quiet tone of voice to expound the subject from a scientific point of view. He declared that if there was any question of shame, he would not be so ashamed to have a monkey for an ancestor as to have been descended from a man who prostituted the gifts of culture and eloquence in the service of prejudice and falsehood. The effect was what journalists call "electrical". One lady fainted; and the writer whose account has here been

followed jumped out of his chair. There is some doubt as to the actual words Huxley used, for the remainder of the sentence was drowned in the applause to which some of the clerics who had "come to curse" contributed.

When the commotion had subsided, Hooker continued the debate, and had no difficulty in showing that Wilberforce had neither the most elementary acquaintance with botany nor the least grasp of those principles expounded in the "Origin of Species".

From 1862 onwards, Huxley became a serious student of ethnology, and he was soon able to discover evidences of "Man's Place in Nature"—taking this phrase as title for one of his most successful books. Next comes on the scene Sir Richard Owen, a comparative anatomist of the school of Cuvier, who had never adopted the evolutionary hypothesis, and who in particular had committed himself to the anatomical inaccuracy that in the brain of man alone are to be found certain structures, one of which is the "hippocampus minor". We have an echo of this controversy in "The Water Babies". Although the competent anatomist Sir William Flower demonstrated to a gathering of experts

at the College of Surgeons that the brain of the ape does possess a "hippocampus", Owen would never admit his mistake. Huxley showed in opposition to him that the structural differences between man and the higher apes are no greater than those between the higher and the lower apes themselves. In 1866 appeared one of his best known and most widely read books, "Lessons in Elementary Physiology", from which so many of us got our first real physiological information. It has been republished thirty-two times, and is still read, having been brought up to date by Professor Barcroft of Cambridge.

In January, 1869, Huxley performed what Murchison described as the boldest act of his career, for he delivered in Edinburgh on a Sunday evening his famous lecture "The Physical Basis of Life". Royal and (especially) saintly Edinburgh was thoroughly scandalized. But the phrase "the physical basis of life" became thenceforth the definition of protoplasm, and such it remains to the present day.

The year 1869 was notable in another respect, namely, for the invention of the word "Agnosticism", which many people

think is far older than Huxley's time. In the Metaphysical Society founded by Knowles, late editor of *The Nineteenth Century*, Huxley and two or three others were unable to range themselves under any of the familiar sectarian titles, such as Unitarian, Positivist, etc. It was inconvenient to have no class name, so the word "Agnostic" was coined to indicate merely a person who does not know for certain a vast number of things about which other people profess to know everything. How Huxley came to introduce the term had better be told in his own words—

> When I reached intellectual maturity and began to ask myself whether I was an atheist, a theist or a pantheist, a materialist or an idealist, a Christian or a freethinker . . . I came to the conclusion that I had neither art nor part with any of these denominations except the last. . . . They were quite sure they had attained a certain *gnosis*, had more or less successfully solved the problems of existence, while I was quite sure I had not, and had a pretty strong conviction that the problem was insoluble. . . . So I took thought, and invented what I conceived to be the appropriate title of "Agnostic".

The Agnostic position in philosophy is a sort of Scottish verdict of "Not proven".

In this year, as President of the British

Association, Huxley gave the address on "Biogenesis and Abiogenesis", in which he discussed the age-long problem of the possible emergence of life from matter that was not living. The subject had really been closed in favour of Biogenesis by the experiments of Pasteur, but certain experiments by Professor Bastian of King's College seemed to raise fresh doubts. Huxley repeated Pasteur's experiments, and showed once more that the supposed appearance of life from the non-living was due to insufficient sterilization of the medium—a pitfall that had proved disastrous to many earlier investigators.

In 1870 he was elected to the London School Board, where he fought long and valiantly for the claims of natural science in national education. It is significant that he was entirely in favour of retaining the use of the Bible in schools, as a means of introducing religious and ethical ideas in the education of the young. In 1871 he had a serious breakdown in health. A visit to Switzerland always did him good, but this year he went to St Andrews, where he wrote —among other reviews—a notice of Darwin's "Descent of Man", which had just been published. On seeing one of these, Hooker

said: "When I read Huxley, I feel quite infantile in intellect".

It will easily be realized that a "pure scientist", with a family to support, could not cease work and depart for a long holiday on his own resources. So Huxley was overcome with gratitude when he received a letter from Darwin telling how a few friends had placed £2,100 to his credit in the bank. Darwin was showing practical sympathy with his "bull-dog". He sailed to the Mediterranean, where he enjoyed everything he saw—Gibraltar, Italy, Egypt, and the tideless sea.

His famous "Course of Elementary Instruction in Practical Biology" was published in 1875, and revised thirteen times before 1888. When Darwin received his copy, he exclaimed: "Lord! How I wish I had gone through such a course". About this time Huxley made a memorable speech at Birmingham on the occasion of the unveiling of the fine statue of Priestley. In the life of Priestley he had a congenial theme, for there he saw a pioneer in science and in political reform, who had been persecuted and driven from England for opinions which later became the very commonplaces of orthodoxy.

The British Association meeting in 1874 at Belfast has become famous for the Presidential address delivered by Tyndall which for long was regarded as the exposition of materialism *in excelsis*. At this meeting Huxley delivered his memorable lecture on "Animals as Automata", in which he showed how capably he could handle the psychological and the historical aspects of a biological problem, his estimate of Descartes's contributions to physiology being particularly illuminating. In this discourse we find an interesting treatment of functional momentum and the ever debatable relations of consciousness to the brain. It is in the same address that consciousness is regarded as an epiphenomenon. "The soul", said Huxley "stands related to the body as the bell of a clock to the works, and consciousness answers to the sound which the bell gives out when it is struck." To us who believe in consciousness as a cause of neural activity, this view—which loses sight of the reality of psychogenesis—is only a partial one, yet it was one that needed to be emphasized at the time at which it was proclaimed.

The year 1876 saw Huxley in the thick of the controversy that raged round the

subject of vivisection. Even at the present day there is not much common-sense shown by the opponents of this greatly misunderstood practice. Huxley was asked to serve on this first Commission, and he did so, believing —with all sensible lovers of animals—that the needful experiments should be done decently and in order, which means under appropriate legal safeguards. One sentence he wrote on the subject has so true a prophetic ring that it must be quoted: "Unless the fanaticism of philozoic sentiment overpowers the voice of humanity, and the love of dogs and cats supersedes that of one's neighbour, the progress of experimental physiology and pathology will indubitably place medicine and hygiene on a rational basis". Huxley served on no fewer than nine other Commissions.

In the summer session of 1875 he took over the academic duties of Professor Wyville Thomson, who was still absent on the *Challenger* expedition. In eleven weeks he described the entire animal kingdom in fifty-four lectures. A member of his class has left a vivid impression of it. Without a knowledge of Greek, he said, he had the greatest difficulty in following the lecturer,

and he considered that the strain on his attention for the one hour was equal to that of a whole day's work. Writing from Edinburgh during the first week of this class, Huxley says that the numbers are over three hundred, and that for the first few days he noticed a number of parsons mustered in strength. "I fear", he adds, "that they came to curse, and did not remain to pay." His joy on receiving a cheque for £1,000 at the end of the term was intensified by the reflection that a southerner had actually gone to Scotland and made some profit out of the natives. His sense of humour was indeed very highly developed. Only the lack of space prevents recital of some excellent stories told of him and by him. He was, for one thing, an apt phrase-maker, calling Sir John Richardson, the gruff but good-hearted Arctic explorer, "that fine old Polar Bear".

In a letter to his daughter, Huxley confides to her that all women are mysteries, but, he adds, "there are mysteries of iniquity as well as mysteries of godliness". Describing one of his answers to the Bishop of Peterborough as "soft", he continued: "soft not with the softness of the answer which

turneth away wrath, but with that of the pillow which smothered Desdemona". He tells Knowles with zest that whereas he had called the Gadarene swine "porters of the devils", the printer had made this read "porkers of the devils"—which seemed much more sensible. Still more annoying was it when Huxley's phrase "the current formula" (of the Lord's Prayer) appeared as the *canting* formula. His handwriting, as happens with many thinkers, was extremely illegible, Dean Stanley's alone being a little worse.

In the autumn of 1876, accompanied by his wife, he visited the United States of America, where he was promised a welcome warmer than that which had been given to the Prince of Wales. What he particularly wanted to see was the unique collection of fossils from the Tertiary strata of the far West, which had been brought together at Yale University by his friend, Professor Marsh. On meeting him at the station, Marsh suggested that he should see first the fine buildings of the university, but Huxley replied: "I can see bricks and mortar in my own country: show me what you have got inside". The gem of the collection was a series illustrating the ancestry of the horse.

Huxley prophesied that there was a " missing link ", a five-toed equine to be found somewhere, and within two months of this prediction Professor Marsh found the fossil in the lowest Eocene.

Not only was his sense of humour strongly developed, but his sense of what was fitting was equally pronounced. He refused to join in a movement to put pressure on the Dean of Westminster that the body of George Eliot should be buried in the Abbey. Of all people in the world, it was Herbert Spencer who urged this amazing request; and to him Huxley wrote a most sensible letter, pointing out that the Abbey was a Christian church, and not a Pantheon. He added: " Those who elect to be free in thought and deed must not hanker after the rewards . . . which the world offers to those who put up with its fetters ".

About this time he refused a call to the Chair of Physiology at Oxford, preferring to remain in the intellectual maelstrom of the great city on the Thames rather than enter upon the academic isolation of the ancient city on the Isis. The year 1882 was full of incident for him. In that autumn he was elected President of the Royal Society,

thus winning the bluest of blue ribbons in British science. Francis Balfour, the Cambridge embryologist, was killed in the Alps, and on April 19th Darwin died. As was appropriate, Huxley wrote the obituary notices in *Nature* and in the "Proceedings of the Royal Society". In 1885 the "whirligig of time brought its revenges", for in that year he was actually made a D.C.L. of Oxford, on a spot only a stone's throw from that other where, twenty-five years before, he had been within very little of being lynched. The home of lost causes had forgiven him.

In June of this year, on the occasion of the unveiling of a statue of Darwin at the head of the stairs in the Great Hall of the Museum at South Kensington, in presence of the Prince of Wales and a distinguished company, Huxley made one of his famous speeches, containing the pregnant sentence: "Science commits suicide when it adopts a creed". At the close of the year, being sixty years of age, he had to retire on a small pension. But it was impossible that he could be intellectually dead, whatever he might be officially, as he himself put it. So he entered upon a protracted discussion

in *The Nineteenth Century* with Gladstone on the general subject of Genesis *versus* modern zoology. These articles, which were trenchant and very brightly written, were eagerly read by thoughtful persons. No sooner was the Gladstone controversy over, than Huxley found himself attacked by the Rev. Dr Wace, Principal of King's College, London, who declared that Agnosticism was a mere evasion, and that Agnostics should forthwith be called infidels. This was just what Huxley had been at such pains to declare ought not to be done. Once more he explained how Agnosticism "simply means that a man shall not say he knows or believes that which he has no scientific grounds for professing to know or believe". The narrative of the bedevilled swine figured prominently in this spirited debate.

In 1889 he built a house at Eastbourne which he called "Hodslea"—the original of the name of his family. Thither he retired for the tonic of the fine air of Beachy Head, so that the distractions of London saw less and less of him. He went to the city from time to time to discharge such public duties as were still unavoidable. Lord Salisbury consulted him, on behalf of the Queen,

with reference to the institution of an Order analogous to the Prussian for recognizing eminence in literature, art and science. Doubtless the Order of Merit founded by King Edward was the outcome of this conference. Huxley suggested that the Council of the Royal Society might submit names of persons worthy to be admitted to the order.

His friends were dropping off. In 1893 Jowett and Sir Andrew Clark, his physician, died. In the same year died John Tyndall; and Huxley had the unique experience of hearing his own funeral sermon preached by a not too clear-headed divine. He would still have his joke. Apropos of his last Royal Academy banquet, he wrote that it was pleasant to revisit the world, and to have a glimpse at the flesh (on the walls of the Academy) and even of the devil (for several bishops were there).

. . . . .

His last public appearance was on August 8th, 1894, at the Oxford meeting of the British Association, where he seconded the vote of thanks moved to the President —Lord Salisbury—for his address. The scene was one not easily forgotten. It was the

evening of a perfect English summer day, and the tiered seats of the venerable Sheldonian Theatre were filled by one of the most distinguished companies that had ever been gathered there. A former Prime Minister of England had been thanked for his discourse by the greatest mathematical physicist since Newton—Lord Kelvin. Professor Huxley's task on that occasion was one of the most difficult he had ever been called upon to perform. For in the speech to which we had just listened, Lord Salisbury had in playful banter enumerated all the *a priori* and theoretical difficulties which a layman finds in adopting the evolutionary hypothesis, and he had laid almost undue stress on what was still disputable, uncertain and unknown in science. When Lord Kelvin had sat down, Huxley rose slowly from his place, robed in the scarlet gown of an Oxford D.C.L. Some were afraid his voice would not fill that immense auditorium. Some thought the physical strain would be too much for him. Many expected him to repudiate indignantly the suggestion that the evolutionary theory presented more problems than explanations, after it had been before the scientific world for thirty-

six years. But none of these things happened. In Professor Osborn's words: "He raised his figure and his voice to their full height, and veiled an unmistakable and vigorous protest in the most gracious and dignified speech of thanks". It was the fitting conclusion to a great career.

Huxley died on June 29th, 1895, and was buried neither in Abbey nor in Pantheon, but at Finchley—in the same grave as his first-born. Possibly to no other man did honours and distinctions come in so unbroken a series. He was a graduate of ten universities, a member of seventeen learned Societies in London alone, of fourteen elsewhere in the Empire, of eight in the United States, and of thirty-seven in other parts of the world. In spite of his ill-health, his industry was prodigious. He was the author of thirty-one books, eighty-eight essays, and one hundred and seventy-nine scientific memoirs.

The place of biology, and especially its practical teaching in British education to-day, is the outcome of his long fight against the old traditional and purely linguistic training. He was not merely a destructive critic; he had something to offer in the place of each thing which he condemned.

By the spoken and by the written word, Thomas Henry Huxley inaugurated what it is not too much to call the era of the recognition of science within the British Dominions. He was the Carlyle of Natural History. But, unlike the Scottish sage, besides finding fault, he laid foundations which can never be moved.

He found science a Cinderella ; he left her a Princess.

XII

BIOLOGY IN SHAKESPEARE

The term "Biology" for our present purpose is used in a very wide sense, for by Biology we shall understand all those sciences which have anything whatever to do with life.

We shall not enter upon a catalogue of all the plants and animals referred to by Shakespeare, interesting undoubtedly as that study might be made in competent hands. Nor shall we remark upon the various diseases alluded to by our and the world's greatest dramatist.

We shall consider a few allusions to such subjects as have, in our present day understanding of them, some distinct physiological or psychological interest.

If we begin with Sleep, it will probably make plainer what one is striving to express.

Now we need not fear any contradiction

when we say that in Shakespeare's time there was no physiological theory of sleep.

While all physiologists are not even now agreed on what exactly it is that induces the state of the nervous system and the mind which we call "sleep", yet there is considerable unanimity about the chief co-operating causal factors.

We recognize that the accumulation of certain chemical substances, which we may call "fatigue-poisons", circulating in the blood coupled with a diminution of the vigour of the circulation through the brain, along with the absence of sensations and of the more strictly intellectual activities, predisposes to sleep. There are, therefore, at least four participating factors which, for short, we may call the fatigue, the vascular or circulatory, the sensory and the mental respectively.

And conversely, the absence of fatigue, too much blood in the brain, the presence of sensations and of mental pre-occupations are responsible for the corresponding insomnias.

Shakespeare has noticed at least two of these factors for sleep in the famous and familiar address to Sleep by the King in *King Henry IV*, Part II (Act III. Sc. 1)—

"How many thousand of my poorest subjects
Are at this hour asleep! O sleep, O gentle sleep,
Nature's soft nurse, how have I frighted thee,
That thou no more wilt weigh my eyelids down,
And steep my senses in forgetfulness?
Why rather, sleep, liest thou in smoky cribs,
Upon uneasy pallets stretching thee,
And hush'd with buzzing night-flies to thy slumber;
Than in the perfum'd chambers of the great,
Under the canopies of costly state,
And lull'd with sounds of sweetest melody?

. . . . . .

Canst thou, O partial sleep! give thy repose
To the wet sea-boy in an hour so rude;
And, in the calmest and most stillest night,
With all appliances and means to boot,
Deny it to a king? Then, happy low-lie-down!
Uneasy lies the head that wears a crown."

In this famous soliloquy Shakespeare contrasts the insomnia of the King brought on by the mental factor—the cares of state—with the sound sleep of his fatigued subjects and especially with the chemically induced slumbers of the tired-out "sea-boy". The sleep of the latter, by the way, is of that type which even the storm cannot disturb and which is not accompanied by the usual loss of tone of the muscles, for he does not lose his balance or fall from the rigging.

This maintenance of the posture is in contrast with the loss of muscular tone in

drunkenness, for, says Hastings in *King Richard III* (Act III. Sc. 4)—

> ". . . like a drunken sailor on a mast;
> Ready, with every nod, to tumble down
> Into the fatal bowels of the deep."

It is well known that in certain cases the very deepest type of fatigue-induced sleep is compatible with the maintenance of the posture and equilibrium as when in the good old days postillions fell asleep on horse-back and did not fall off, when to-day cross-channel swimmers are found swimming asleep; when persons thoroughly exhausted have walked miles in their sleep, and finally when sentries have slept but not fallen down.

The same idea—of chemically-induced sleep—is given us in *Cymbeline* (Act III. Sc. 6)—

> " Weariness
> Can snore upon the flint, when resty sloth
> Finds the down pillow hard;"

and this is echoed by these words from Ecclesiastes—

> " The sleep of a labouring man is sweet."

The mental factor in sleeplessness is well described in *Romeo and Juliet* (Act II. Sc. 3)—

"Care keeps his watch in every old man's eye,
And where care lodges, sleep will never lie;"

The phrase, "To purge him of that humour that presses him from sleep," which occurs in *A Winter's Tale* (Act II. Sc. 3) is probably an allusion to what in modern language we should call a toxic source of insomnia. Of course it refers back to the old view of the four humours which from the time of Hippocrates were assumed to be the causes of disease. These were—blood, phlegm, yellow bile, and black bile.

It seems particularly interesting that Shakespeare has no allusion to the second sleep-producing factor, namely, the diminution of the flow of blood through the brain.

To appreciate this source of sleep we must, in some measure, understand the circulation of the blood. Now the circulation of the blood, though taught by Harvey from 1616 onwards, was not, as it were, common property until he published his famous "De Motu" in 1628. This treatise, written in Latin, was brought out at Frankfort-on-the-Maine twelve years after Shakespeare was in his grave. Shakespeare knew only the views of Galen, which had been taught in medical schools for 1,400 years.

It is certainly striking that the very aspect of sleep which depends on a knowledge of the circulation of the blood should be the one and the only one to find no place in Shakespeare's writings. The reason involves no mystery; he could not know of the circulation of the blood because that great fact in physiology had not been revealed by its discoverer at the time at which the plays were written. What was known of the sources of sleep was, like all else observed by the great dramatist, recorded with astonishing fidelity to Nature.

Sleep, as everyone knows, is the great restorer of energy to the nervous system, for prolonged sleeplessness is much more damaging than lack of food. A sleepless animal at the end of three to four days is as miserable as a starved one at the end of ten to fifteen.

This aspect of things is well described in *Macbeth* (Act II. Sc. 2)—

> "Macbeth does murder sleep, the innocent sleep;
> Sleep, that knits up the ravell'd sleeve of care,
> The death of each day's life, sore labour's bath,
> Balm of hurt minds, great nature's second course,
> Chief nourisher in life's feast."

We are given here six different similes to express the same idea.

Sleep is literally a nourisher in that a certain amount of sleep represents a certain amount of food; we are more hungry after four waking hours than after eight to ten hours of sleep.

Puppies deprived of sleep died at the end of five days, although they were taking food; whereas controls allowed to sleep as much as they wished, but from which food was entirely withheld, survived to the twentieth day.

I submit that Shakespeare has embodied the substance of this modern knowledge in the passage we have just heard.

In sound sleep the sensory centres are not accessible to impulses from outside, not even to painful impressions, hence it is perfectly true that—

> "He that sleeps feels not the toothache".
>
> (*Cymbeline*, Act V. Sc. 4)

The power of sleep to banish sorrow in total unconsciousness is well put by Helena in *A Midsummer Night's Dream* (Act III. Sc. 2)—

> "And, sleep, that sometimes shuts up sorrow's eye,
> Steal me awhile from mine own company."

Shakespeare, however, shared in the

popular tendency to regard sleep as closely resembling death. Physiologically this is quite wrong: sleep is, as he has himself told us, the great restorer: in sleep we recuperate, we sleep to wake.

Nevertheless when he exclaims in *Cymbeline*, "Sleep, thou ape of death" (Act II. Sc. 2), and again, "Shake off this downy sleep, death's counterfeit" (*Macbeth*, Act II. Sc. 3), he is in illustrious company, for Shelley wrote—

"Death and his brother, Sleep" (*Queen Mab*), and Tennyson called sleep, "Death's twin brother".

Here the poets have not exhibited that intuition into the significance of things as they really are which distinguishes some of their other intellectual penetrations.

Any references that Shakespeare makes to the vascular system—to the heart, arteries, veins and blood—must be peculiarly interesting to us, seeing that our great poet was a contemporary of that other illustrious Englishman, Dr William Harvey, the discoverer of the circulation of the blood. Shakespeare died one week after Harvey, as Lumleian Lecturer, gave his first public lecture at the College of Physicians on April 16th, 1616.

Shakespeare was fourteen years older than Harvey, for he was born in 1564 and Harvey in 1578, so that they were contemporaries for 38 years.

There is very little likelihood of their having met, for Harvey was a student of Medicine at Padua from 1598 to 1602, during the very time when Shakespeare was at the height of his activity.

Some uncritical writers have assumed that because Shakespeare and Harvey were contemporary, Shakespeare must have known of the new views of the circulation of the blood which were disturbing the anatomists and the medical schools of Europe. But even if the two great men ever met, the young physician was not in the least likely to discuss with his senior, the actor, a quite revolutionary view of a matter of pure physiology.

In those days every discovery in Medicine was not heralded in the streets, nor proclaimed from the house-tops.

Some writers have thoughtlessly suggested that Shakespeare could have learned of the Harveian doctrines from his son-in-law, Dr Hall of Stratford-on-Avon ; but Shakespeare's daughter married Dr Hall in 1607 twenty-

one years before the celebrated "De Motu" saw the light not even in England, but at Frankfort-on-the-Maine. We have no reason to suppose that worthy doctor Hall was endowed with any transcendental intuitions.

From these considerations we should *not* expect Shakespeare to have been acquainted with the true knowledge of the circulation of the blood; and as a matter of fact there is not one word in all his writings to suggest that he did know of it.

In this respect at least he is not beyond his age, he reflects it; his vascular physiology is entirely pre-Harveian, in other words it is Galenical; it is in accord with the views taught in the medical schools of Europe for 1,400 years, the views of Claudius Galen, that great dictator in all matters medical.

Galen, although resident in Rome, physician first to the Emperor Marcus Aurelius and later to Commodus, and surgeon to the school of gladiators, was of Greek descent. He was born in the Greek colony of Pergamos in Asia Minor about 130 A.D.

Many of his views were, as we might suppose, based on the still older ones of Hippocrates and of Aristotle and of the

Anatomists of the famous school of Medicine at Alexandria.

At least the names of these two great masters in medicine were known to Shakespeare, for he makes Sir Hugh Evans in the *Merry Wives* say of Dr Caius (Act III. Sc. 1)—

> " He has no more knowledge in Hibbocrates and Galen,—and he is a knave besides ; "

Galen is mentioned again along with Hippocrates, in the same play—

> " What says my Hippocrates ? My Galen ? "
>
> (Act II. Sc. 3).

And once more in *Coriolanus* we have the phrase—

> " the most sovereign prescription in Galen "
>
> (Act II. Sc. 1).

Lastly, Galen is mentioned along with Paracelsus in *All's Well* (Act II. Sc. 3), where Parolles refers to " Galen and Paracelsus " as " all the learned and authentic fellows ".

This is interesting in that Paracelsus had died only twenty-three years before the date of Shakespeare's birth.

Before Galen's time it was believed that blood was found in the veins only, and that in them it travelled both up and down for the nourishment of the body ; and since

the large arteries after death are empty, it was taught that these vessels in life contained not blood but only "vital spirits".

Galen, by tying an artery in two places and cutting out the ligated piece, showed at once that during life arteries did contain blood.

To appreciate the pre-Harveian physiology we must understand the Galenical doctrine of spirits, which very briefly was—the food, digested in the intestines, was absorbed thence and carried to the liver, where, after elaboration, it became possessed of "natural spirits". It passed to the right side of the heart still as crude blood, whence it went up and down the veins in the manner of a tide. In modern language "natural spirits" were the equivalent of "power of nourishing". Some of this crude or venous blood was supposed to percolate through the septum dividing the right from the left side of the heart. There are in reality no pores; but they were not denied until by Vesalius in 1543, and disproved later experimentally by Harvey.

The blood on the left side of the heart was supposed to be mixed with air drawn into it by the act of breathing.

This air cooled " the innate heat of the heart " and engendered in the now scarlet blood the vital spirits which, carried in the bright blood reaching the tissues by the arteries, conferred on these tissues their capacities for performing their functions.

Finally, said Galen, blood plus vital spirits, on reaching the brain, produces there the third and last order of spirits, " the animal ", the production of which by distillation was supposed to go on in the cavities or ventricles of the brain.

In this sense the brain was a still or retort where animal spirits were distilled ; and it may be in allusion to this that Shakespeare uses the word " a limbeck " or " alembic " (al ambeq), the medieval, chemical, Arabic word for a retort or still.

Lady Macbeth is speaking—

> " . . . . . his two chamberlains
> Will I with wine and wassail so convince,
> That memory, that warder of the brain,
> Shall be a fume, and the receipt of reason
> A limbeck only : "
>
> (*Macbeth*. Act I. Sc. 7)

as much as to say, their state of intoxication will reduce the brain to a retort which cannot distil anything.

Cornelius, the doctor in *Cymbeline*, speaking of the poison with which the Queen is working, says—

> ". . . . . there is
> No danger in what show of death it makes,
> More than the locking up the spirits for a time,
> To be more fresh, reviving."

The word "animal" here in relation to the third order of spirits does not mean belonging to a beast; it means "pertaining to the soul" or anima, the Latin equivalent of the Greek psuche (soul or life); the full Latin expression is "spiritus animalis". These "animal spirits", which survive in our every-day speech, were to Galen what nerve-impulses are to us—the impulses which ascended and descended the nerve-fibres as sensory and motor innervations respectively.

A good deal of this old physiology is contained in the speech of Meninius Agrippa, the friend of Coriolanus, who makes "the belly" speak as follows—

> "'True is it, my incorporate friends,' quoth he,
> 'That I receive the general food at first,
> . . . . . .
> I send it through the rivers of your blood,
> Even to the court, the heart, to the seat o' the brain,
> And through the cranks and offices of man:
> The strongest nerves, and small inferior veins,
> From me receive that natural competency
> Whereby they live':"
>
> (*Coriolanus*. Act I. Sc. 1)

The physiology of this well-known passage is indeed Galenical, but not all of it is erroneous: the abdomen does receive the food upon which ultimately the whole body subsists; it *is* sent by the currents—rivers—of blood to the heart, and some of it does reach the brain. But the phrase "rivers of your blood" precludes the idea of a circulation—a returning of the same blood. Galen taught an up-and-down or tide-like flow; Harvey a flow in one direction with a continual returning—they are totally different things. A river, indeed, flows in one direction but never returns.

In the following passage from *Coriolanus* (Act V. Sc. 1) we have again very much the same ideas regarding the functions of the veins—

> "The veins unfill'd, our blood is cold, and then
> We pout upon the morning, are unapt
> To give or to forgive; but when we have stuff'd
> These pipes, and these conveyances of our blood,
> With wine and feeding, we have suppler souls
> Than in our priest-like fasts:"

Shakespeare certainly recognizes the pre-eminence of the heart and its susceptibility to be disturbed by emotional states, as when he makes Macbeth exclaim—

"Whose horrid image doth unfix my hair,
And make my seated heart knock at my ribs."

(Act I. Sc. 3)

The passage in Julius Cæsar in which Brutus declares—

"You are my true and honourable wife;
As dear to me as are the ruddy drops
That visit my sad heart"

(Act II. Sc. 1)

has actually been taken to prove that Shakespeare not only knew of the circulation, but anticipated Harvey in his discovery.

This is really carrying things too far; we may charitably assign it to excess of hero-worship; but it is perilously near to childishness.

It is true that Shakespeare assigned to the heart a pre-eminence which was beyond what was accorded it in the Galenical physiology; the notion indeed is ever before him as when he says—

"O England! model to thy inward greatness,
Like little body with a mighty heart."

(Chorus before Act II. *King Henry V*)

Shakespeare has no doubt whatever that in fainting it is the heart that is at fault, and that bad news in particular can be a

cause, for in *King Richard III* (Act IV. Sc. 1) Queen Elizabeth says—

"Ah, cut my lace asunder !
That my pent heart may have some scope to beat,
Or else I swoon with this dead-killing news."

But another type of fainting, that due to the sight of blood, was quite familiar to him, for we have in *As You Like It* (Act IV. Sc. 3)—

"Many will swoon when they do look on blood."

Present day physiology calls it an inhibitory, sensori-vascular, reflex action.

Shakespeare knew perfectly well that fresh air is necessary to revive the fainting person, for we are told (*King Henry IV*, Part II. Act IV. Sc. 4)—

"Stand from him, give him air ; he'll straight be well."

—another sensori-vascular reflex—but we do not infer from this that Shakespeare had taken out a course of lectures and demonstrations in First Aid ; no, not even although he says in *Measure for Measure* (Act II. Sc. 4)—

"So play the foolish throngs with one that swoons ;
Come all to help him, and so stop the air
By which he should revive : "

Just as in our everyday parlance the veins come in for much more attention than the arteries, as when we say we have 'foreign blood in our veins', but do not mention the arteries where there must be just as much foreign blood, so, too, in Shakespeare the veins are referred to much more often.

But there is at least one definite allusion to the arteries in *Love's Labour's Lost* (Act IV. Sc. 3), where Biron speaks of "the nimble spirits in the arteries".

This is clearly a reference to the vital (arterial) spirits of the Galenical physiology: and one is almost compelled to think that Shakespeare did not regard blood as in the arteries at all, which is the very old pre-Galenical view, as we have seen.

As a matter of fact, Shakespeare's physiology of arteries is a little confused, for he makes Hamlet say (*Hamlet*, Act I. Sc. 4)—

> "My fate cries out,
> And makes each petty artery in this body
> As hardy as the Nemean lion's nerve.—"

The expression in *King John* (Act III. Sc. 3), "blood . . . runs tickling up and down the veins", is in perfect agreement with pre-Harveian teaching. Even if the word

here should be more appropriately "trickling", it would not alter the sense.

Shakespeare associates life with the blood in the veins, as when we read in *King John* (Act III. Sc. 3)—

> "Whiles warm life plays in that infant's veins."

This is clearly an allusion to the very old Biblical and Hippocratic belief that "the blood *is* the life". Doubtless it was through watching the sacrificial animal die, as its blood ebbed away, that gave rise to this ancient and very natural belief.

In the same strain we have in *King John* (Act V. Sc. 7)—

> " . . . . the life of all his blood
> Is touch'd corruptibly."

There is a passage in *Hamlet* (Act I. Sc. 5) which may refer to the veins and even to the valves in them, where Hamlet is speaking of the poison—"it courses through the natural *gates* and alleys of the body". I do not press the point: it may be quite fanciful.

Shakespeare was acquainted with at least one property of the blood—its odour—known in modern physiology as the "halitus sanguinis"; for in that very remarkable scene in Dunsinane Castle, Lady Macbeth, carrying

a light and walking in her sleep, is shown trying to wash away the stain of the blood of the murdered King and saying—

"Here's the smell of the blood still: all the perfumes of Arabia will not sweeten this little hand."

(*Macbeth*, Act V. Sc. 1)

She has just said in her sleep: "Who would have thought the old man to have had so much blood in him?"

Doubtless the words of Edgar in *King Lear* rise to our thoughts—

"I smell the blood of a British man,"

(Act III. Sc. 4).

Related both to the circulatory and to the nervous system is the action of alcohol; and much that Shakespeare says about this has quite the modern ring as, for instance, in the passage in *King Henry IV* (II, Act IV. Sc. 3), where the effects of sherris-sack are described in detail by the fat knight—

"The second property of your excellent sherris is,— the warming of the blood; which, before cold and settled, left the liver white and pale, which is the badge of pusillanimity and cowardice: but the sherris warms it and makes it course from the inwards to the parts extreme. It illuminateth the face; which, as a beacon, gives warning to all the rest of this little kingdom, man, to arm: and then the vital commoners, and inland petty spirits, muster me all to their captain, the heart."

There is much good physiology here ; alcohol in not too large quantity is a tonic or stimulant to the heart in that it causes it to drive the blood more forcibly into the peripheral vessels, including those of the face. In the phrase, " their captain, the heart", we see Shakespeare once more recognizing the functional pre-eminence of that organ. We notice too the reference to the spirits.

The value of alcohol as a general stimulant is brought out when the dying Antony exclaims—

> " I am dying, Egypt, dying,
> Give me some wine, and let me speak a little."
>
> (*Antony and Cleopatra*. Act IV. Sc. 13)

The notion that the relatively bloodless liver would be pale is not entirely fantastic. That great gland, if washed free of blood, *does* have a pale, greyish hue ; and if therefore a blood-filled liver is the physical basis of courage, there is nothing absurd in the idea that a bloodless and therefore pale liver would be related to cowardice.

In *King Lear* (Act IV. Sc. 2) we have Goneril exclaiming, " milk-livered man ".

The same sort of idea occurs in *Measure for Measure* (Act IV. Sc. 3), where Lucio says—

> " O, pretty Isabella, I am pale at mine heart to see thine eyes so red : "

We should compare this with Lady Macbeth's words—

"... I shame
To wear a heart so white."
(*Macbeth*. Act II. Sc. 2)

and with Gratiano's (*Merchant of Venice*, Act I. Sc. 1)—

"And let my liver rather heat with wine,
Than my heart cool with mortifying groans."

Shakespeare is in no doubt that it is on the brain that alcohol ultimately acts, for he makes Cassio refuse Iago's offer of a stoop of wine in these words—

"Not to-night, good Iago; I have very poor and unhappy brains for drinking: I could well wish courtesy would invent some other custom of entertainment."
(*Othello*. Act II. Sc. 3)

And again: "O that men should put an enemy into their mouths to steal away their brains" (*ibid.*), and once again when Falstaff tells us (*King Henry IV*, Part II. Act IV. Sc. 3)—

"... A good sherris-sack hath a two-fold operation in it. It ascends me into the brain; drives me there all the foolish, and dull, and crudy vapours which environ it."

In the *Twelfth Night* we have the three stages of drunkenness described by the clown—

Olivia asks; "What's a drunken man like, fool?"

Clown : " Like a drowned man, a fool and a madman ; one draught above heat makes him a fool, the second mads him, and a third drowns him."

(Act I. Sc. 5)

It is literally true that death in alcoholic poisoning occurs through paralysis of the respiratory centre with the symptoms, therefore, of asphyxia as from drowning. And it is also true that death often comes on with an accumulation of " water " in the body and in the legs.

The physiology of digestion and of the allied subject of starvation is referred to with Shakespeare's marvellous insight.

Thus, when Gaunt says in *King Richard II* (Act I. Sc. 3)—

" Things sweet to taste prove in digestion sour,"

it is literally true whether we confine the word " sweet " to sugars or allow it to refer to the two other principal food-stuffs.

The sugars, before being finally incorporated into the tissues, it is thought, go through the stage of lactic acid ; and milk-sugar in particular is fermented into that acid with the greatest ease.

The baneful effect upon digestion of unpleasant emotions—worry, sorrow, etc.—was perfectly well known to Shakespeare, for he

makes the abbess in the *Comedy of Errors* say (Act V. Sc. 1)—

"Unquiet meals make ill digestions."

The unravelling of the complete nervous mechanism by which the digestive function is influenced by emotional states for good or ill has been fully worked out only within quite recent years by the great Russian physiologist, Pavlov.

Pavlov has shown that any pleasant and refining conditions—interesting company, music, flowers, fine linen, silver, cut glass etc.—all tend to produce that state of good digestion and appetite learnedly called Eupepsia. This is the sort of thing Shakespeare meant when he said—

". . . the sauce to meet is ceremony,"

(*Macbeth*. Act III. Sc. 4)

and in a line or two later—

"Now, good digestion wait on appetite,
And health on both!"

No less full of insight is the description of the biology of starvation—

". . . . . I sup upon myself,
And so shall starve with feeding.—"

(*Coriolanus*. Act IV. Sc. 2).

What happens in inanition is that the heart and central nervous system are living upon the fat and muscles of the body generally. These "two noble" tissues are literally subsisting upon all the others; and it is therefore biologically correct to say that in starvation one feeds upon oneself.

But further than all this, Shakespeare seems to have grasped the biological significance of life as something *sui generis*, something which, if quenched, can never be revived or, as we sometimes put it, the irreversibility of the death-process. This was far from being the clear-cut belief in his day: life as something unique in plant or animal, impossible of being derived from the non-living, was by no means the doctrine of the learned about 1600, no, nor for two hundred years afterwards. The belief in Abiogenesis, that is life arising from the non-living, was not finally given up until after the work of Pasteur and of Tyndall in the seventies of last century.

But in that most painful scene in that most painful of plays—Othello (Act V. Sc. 2)—Shakespeare makes the Moor, on entering the bed-chamber where Desdemona is asleep with a light beside her, thus

soliloquize when he has determined to smother her—

"Yet she must die, else she'll betray more men.
Put out the light, and then—Put out the light?
If I quench thee, thou flaming minister!
I can again thy former light restore,
Should I repent me:—but once put out thy light,
Thou cunning'st pattern of excelling nature,
I know not where is that Promethean heat
That can thy light relume. When I have pluck'd thy rose,
I cannot give it vital growth again,
It needs must wither."

Shakespeare seems perfectly aware of the breathing test in cases of apparent death; for does not the King in *King Lear* (Act V. Sc. 3) say—

"I know when one is dead, and when one lives;
She's dead as earth:—lend me a looking-glass;
If that her breath will mist or stain the stone,
Why, then she lives."

Lear uses the feather test too—

"This feather stirs; she lives!"

(Act V. Sc. 3)

Shakespeare is fully aware of the great value of rest to the living being, for we have the doctor in the same play (*King Lear*, Act IV. Sc. 4) assuring Cordelia that—

"Our foster nurse of nature is repose,"

and the expression "Life-preserving rest" in the *Comedy of Errors* (Act V. Sc. 1) is in fullest accord with the most recent demonstrations in biology: Anabolism is the learned term given to the vital processes involved in rest.

With regard to drugs, although Macbeth is made to say, "Throw physic to the dogs; I'll none of it" (Act V. Sc. 3), yet Shakespeare evidently did not despise medicines, for Cymbeline avers—

> "By medicine life may be prolong'd, yet death
> Will seize the doctor too."
>
> (*Cymbeline*, Act V. Sc. 5).

Apropos of drugs, we have in the same play two references to what is called to-day in some quarters "vivisection": they are both by Cornelius, the physician, who, speaking of the Queen, says—

> 'Those she has
> Will stupify and dull the sense awhile:
> Which first, perchance, she'll prove on cats and dogs;
> Then afterward up higher;"
>
> (Act I. Sc. 6)

and again in Act V. Sc. 5—

> "The queen, sir, very oft importun'd me
> To temper poisons for her; still pretending
> The satisfaction of her knowledge only
> In killing creatures vile, as cats and dogs
> Of no esteem:"

The promise shall be kept, and we shall refuse to traverse the wide field of the more purely medical lore in the plays; but as the references to surgical conditions are more interesting and more numerous than are generally supposed, let us notice one or two of these.

Surgery is concerned with wounds, with preventing them becoming poisoned, with the cicatrices left by them whether accidental or produced by the knife, and finally with the setting of bones, which have been broken.

First of all Shakespeare seems to have known of the surgeon's custom of comparing his incisions to letters of the alphabet, for in *Antony and Cleopatra* (Act IV. Sc. 7) we read—

> "I had a wound here that was like a T,
> But now 'tis made an H."

Of course he knew the domestic use of cobweb in causing blood to clot, for Bottom says (*A Midsummer Night's Dream*, (Act III. Sc. 1)—

> ". . . . . Good
> master cobweb: If I cut my finger, I shall make
> bold with you."

A tourniquet is evidently alluded to in *Othello* (Act V. Sc. 1), where Iago calls for

a garter to bind Cassio's leg just cut in two, and then exclaims—

> "O for a chair
> To bear him easily hence!"

wherein we get once more evidences of intelligent "first aid".

The sepsis or festering of wounds was, until Lister's time, a perennial source of worry to the surgeon.

In *King Richard II* (Act V. Sc. 3) we read—

> "This fester'd joint cut off, the rest rests sound;
> This, let alone, will all the rest confound,"

which as a surgical maxim could not be bettered to-day.

Shakespeare evidently understood that a wound could be infected, and yet no mischief be visible from the surface, for we have in *Hamlet* (Act III. Sc. 4)—

> "It will but skin and film the ulcerous place;
> Whiles rank corruption, mining all within,
> Infects unseen."

Shakespeare seems to have known about one kind of infection at least in the sense that moulds or fungi are to blame for it, for he says in *Hamlet* (Act III. Sc. 4)—

> ". . . . . like a mildewed ear
> Blasting his wholesome brother."

At the same time we must not infer that the great dramatist was beyond his time in the matter of supposing that life could be engendered in decomposing bodies, for Hamlet says (Act II. Sc. 2)—

> "If the sun breeds maggots in a dead dog."

He understands that wounds must heal gradually, that what we call the "vis medicatrix naturæ" has its own rate of working, for, says Iago (*Othello*, Act II. Sc. 3)—

> "How poor are they that have not patience!
> What wound did ever heal but by degrees?"

As a bland application to a raw wound we have white-of-egg recommended in King Lear (III, 7) where a servant says—

> "I'll fetch some flax and whites of eggs
> To apply to his bleeding face."

Having been healed, we call the scar a cicatrix; and so did Shakespeare, for Volumina in *Coriolanus* (Act II. Sc. 1), says of Marcius—

> "There will be large cicatrices to show the people when he shall stand for his place."

It is well known that old wounds do, from

time to time, give some uncomfortable sensations: it may be in allusion to this that Marcius in *Coriolanus* (Act I. Sc. 9) says—

> "I have some wounds upon me, and they smart
> To hear themselves remember'd."

Finally, it is well known that when two portions of a broken bone are united by what surgeons call "callus", and that when this becomes ossified, it is of a consistence much denser and therefore much stronger than either of the two bits of the bone that has been fractured: hence—

> "If we do now make our atonement well,
> Our peace will, like a broken bone united,
> Grow stronger for the breaking."

says the Archbishop of York in *King Henry IV* (Part II. Act IV. Sc. 1).

As might be expected, the most penetrating and remarkable pronouncements of Shakespeare are those which refer to the *brain*, the senses and the mind. In Shakespeare's day the various emotions were not all referred to states of excitement in the cortex cerebri (grey matter of the brain) and left there; they were distributed amongst the various viscera.

Even the highest mental processes were not originally thought to have their exclusive seat in the brain ; for the ancient Egyptians and later Aristotle believed the mind or soul to reside in the heart.

This view was held, for instance, by Vico (1678-1774) in opposition to Descartes as late as the middle of the seventeenth century. Descartes, as is very well known, placed the soul in the pineal body—a peculiarly unfortunate localization, seeing that the pineal body consists only of some atrophied cells surrounding some crystals of mineral matter, " brain sand " or dust and—

> " Dust thou art, to dust returneth
> Was *not* spoken of the soul."

Even van Helmont (who died in 1644) thought the soul was in the pit of the stomach, the pylorus. Certain early Greek philosophers had indeed held that the soul was in the diaphragm, obviously because that great muscle of breathing is so accessible to emotional disturbances.

Although Galen regarded the brain as the true seat of the soul or intellect, this did not prevent the various internal organs from being thought related in some special way to the passions and emotions.

Thus, Pistol in *The Merry Wives* (Act II. Sc. 1), says that Falstaff loves Ford's wife " with liver burning hot ".

The ascription of anger to the spleen has hardly departed from our everyday speech, as when we speak of a " fit of the spleen " or " a splenetic man " as meaning an angry one.

Shakespeare, if he followed any school of thought in respect of the brain versus other seats of the soul, followed that of Galen rather than that of Aristotle, for he makes Prince Henry in *King John* say of the King—

> " It is too late ; the life of all his blood
> Is touch'd corruptibly ; and his pure brain
> (Which some suppose the soul's frail dwelling-place,)
> Doth, by the idle comments that it makes,
> Foretell the ending of mortality."
>
> (Act V. Sc. 7)

In other words, Shakespeare will not dogmatize about the brain as the seat of the soul, but he lets us understand that he knows of some who so regard it.

The delirium of the dying is clearly referred to in the two words " idle comments ".

Whatever Shakespeare did or did not believe about the cerebral seat of the soul, he was in no doubt at all that what nowadays we call hallucinations are very directly the

products of disordered states of the brain.

The best known example of this is the "dagger of the mind", that elusive weapon which Macbeth saw, but could not lay hold of (*Macbeth*, Act II. Sc. 1)—

"Is this a dagger which I see before me,
The handle towards my hand? Come, let me clutch thee:
I have thee not, and yet I see thee still.
Art thou not, fatal vision, sensible
To feeling as to sight? or art thou but
A dagger of the mind, a false creation,
Proceeding from the heat-oppressed brain?
I see thee yet, in form as palpable
As this which now I draw."

We have everything here: the visual hallucination of the dagger—a dagger of the mind, and it is all traced to Macbeth's disordered brain.

Even the actual language cannot be improved upon after 300 years: *it is poetry in close touch with science.*

Undoubtedly a visual hallucination is referred to by the Queen in *Hamlet* (Act III. Sc. 4) as the ghost disappears—

"This is the very coinage of your brain,
This bodiless creation ecstasy
Is very cunning in."

Possibly one of the most remarkable passages of biological import in all the plays

is one in *Love's Labour's Lost* (Act IV. Sc. 2), where the schoolmaster, Holofernes, speaks of ideas in these words—

"These are begot in the ventricle of memory, nourished in the womb of pia mater, and delivered upon the mellowing of occasion;"

One of the interesting things about this statement is that it involves two technical terms of anatomy—a "ventricle of the brain" and the "pia mater"; the latter, the anatomist's name for the soft delicate membrane which, closely investing the grey matter of the hemispheres, conveys to it its nutrient blood-vessels.

"The ventricle of memory" was a phrase of the Arabian doctors of Medicine, who taught that the brain possessed three cavities or ventricles in which resided the three mental faculties as follows—sensations in the anterior, imagination in the middle and memory in the posterior one. Those views were adopted by the Doctors of Theology of the Church in the Middle Ages.

Against this particular belief Vesalius inveighed in his celebrated treatise, "De Corporis Humani Fabrica," published in 1543. He wrote—

"I wonder at what I read in the scholastic theologians and the lay philosophers concerning the three ventricles with which they say the brain is supplied."

Modern anatomists describe five ventricles.

Here Shakespeare adopts the terminology of the mediæval writers, although it is by no means easy to see how he came to have access to it—the man who, when he died, left not a book behind him.

The phrase "nourished in the womb of pia mater" is, if anything, still more obscure; but this is not the only place in the plays where this membrane is mentioned.

The Clown in *Twelfth Night* (Act I. Sc. 5) says—

"Whose skull Jove cram with brains! for here he comes, one of thy kin has a most weak pia mater."

And once more it is referred to in *Troilus and Cressida* (Act II. Sc. 1), where Thersites declares of Ajax that—

". . . . . his pia mater is not worth the ninth part of a sparrow."

The pia mater does literally nourish the brain, and therefore metaphorically may be said to bring to development anything functionally related to the activity of the brain.

Whether Shakespeare really knew what the pia mater is, cannot now be determined; but assuming that ideas are begot in a cerebral ventricle (which they are not), it would be permissible to regard them as nourished by the membrane that nourishes the organ of thought. The completion of the analogy between giving birth to a child and bringing forth a thought is thus made possible.

Apropos of nourishment of the central nervous system, there is an exceedingly striking statement in *Antony and Cleopatra* (Act IV. Sc. 8), where Antony says—

"Yet have we have a brain that nourishes our nerves."

We have only to translate this into modern physiology to perceive, what is literally true, that the cells of the brain are trophic for, that is, preside over, the nourishment or vitality of nerves. This is precisely what the brain does for the nerves; hence it has been called their "highest trophic realm". Now in this sense it is impossible that Shakespeare could have known the facts; not until the microscope revealed that every nerve-fibre proceeds from a nerve-cell and that, severed from the cell, the fibre dies,

could we know all that is implied in this line. Not only has it the modern ring: we are almost compelled to regard it as prophetic.

There is another almost equally remarkable utterance regarding the nervous system where Hamlet says (Act III. Sc. 4)—

> ". . . . Sense, sure, you have,
> Else you could not have motion:"

The principle that sensory impressions must precede motor in the education of the nervous system is nowadays regarded as of immense practical importance. The fact could not possibly have been known to Shakespeare that those tracts in the central nervous system which subserve sensations are functionally developed a considerable time before those which subserve motion. We must regard this as one of those remarkable intuitions into scientific truth of which at times the poet's mind gives us such excellent examples.

Apropos of the development of the body, Shakespeare has not failed to note the "breaking" of the voice coincident with puberty in the male. The passage is in the *Merchant of Venice* (Act III. Sc. 4),

where Portia enumerates the various things she will do when she assumes the rôle of a young man ; one of them is—

> " And speak, between the change of man and boy,
> With a reed voice : "

Physiologically allied to this subject is the effect of castration on the voice : this, as is well known, prevents the male vocal cords lengthening so that the voice remains boyish and high pitched.

Coriolanus (Act III. Sc. 2) says—

> ". . . . My throat of war be turn'd,
> . . . . . into a pipe
> Small as a eunuch,"

Shakespeare has some peculiarly penetrating remarks under the heading of the biology of the senses.

With regard to vision, the first phenomenon we might notice is that of the coloured after-image (as it is technically called) associated with some degree of retinal fatigue.

It is where Katherine, in *The Taming of the Shrew* (Act IV. Sc. 5), says—

> " Pardon, old father, my mistaking eyes,
> That have been so bedazzled with the sun,
> That everything I look on seemeth green : "

This experience must be familiar to many; if the eyes are over-stimulated by exceedingly bright sunshine, and one goes suddenly indoors, everything takes on a rather ghastly pale-green colour.

The next example has to do with reflections of light from the cornea.

When you look closely into the eye of another person, you see a tiny image of yourself reflected from the convex mirror of the other eye; these images we know in biology as the "Purkinje-Sanson" images. They are clearly referred to in *Troilus and Cressida* (Act III. Sc. 3), where Achilles says—

> ". . . . . eye to eye oppos'd
> Salutes each other with each other's form."

One of the most interesting conditions related to the sense of Vision is the trance of Lady Macbeth.

It is in the same scene as that in which we found the reference to the smell of blood (Act V. Sc. 1).

Lady Macbeth is being watched by the Doctor and by a lady-in-waiting who remarks that she is "fast asleep". The doctor observes, "You see, her eyes are open"; to

which the lady replies, "Ay, but their sense is shut."

Now first of all this is not natural sleep, for in that condition the eyelids are always closed; it is a state allied to somnambulism or ambulatory trance. In this state the centre for vision in the brain is inhibited and functionless, so that although the eyes are open, the brain behind them is not perceiving anything, and therefore the individual is psychically blind. The state is akin to that of the mind-blindness induced in hypnotic trance.

The unpleasant, subjective sensation of giddiness is noticed several times in Shakespeare's plays.

"Giddiness" is the name given to the subjective aspect of a disturbance in the sensory apparatus for the appreciation of one's orientation in space; it is the perceptual aspect of impending or actual overthrow of the equilibrium.

There are two varieties of giddiness or vertigo; one where the sufferer is unable to maintain his balance and, feeling faint, falls or tends to fall to the ground—a condition most usually the result of a diminution of the blood-supply to the brain.

Since the whole brain—cerebrum and cerebellum—suffers from this anæmia, the sensory centre for vision is rendered functionless, in consequence of which the sight fails or, as the patient puts it, "everything goes dark".

This is precisely what King Henry complains of (*King Henry IV*, Part II. Act IV. Sc. 4)—

"And now my sight fails, and my brain is giddy:——"

Let us note once again that Shakespeare attributes the giddiness correctly to the organ involved, the brain itself.

A very common cause of the interference with (inhibition of) the heart that produces this anæmia of the brain is the reception of bad news, as when King John says (Act IV. Sc. 2)—

"Thou hast made me giddy
with these ill tidings——"

The other variety of giddiness is that known as "rotational vertigo"—the sort that we experienced when, as children, we spun round our vertical axes, suddenly stopped and were for a minute or two exceedingly giddy, unsteady, and perhaps also slightly sick.

In rotational giddiness, external objects seem to be moving round in the direction opposite to that towards which the person last turned. This apparent movement of external objects is exactly what is alluded to in *The Taming of the Shrew* (Act V. Sc. 2)—

'He that is giddy thinks the world turns round."

Of course we know that if we are giddy we can correct the giddiness and the illusory movement of the external world by turning round in the direction opposite to that in which the giddiness was produced; we used to do this too as children.

This is precisely what Shakespeare refers to when he makes Benvolio in *Romeo and Juliet* (Act I. Sc. 2) say—

"Turn giddy, and be holp by backward turning;"

One of the most obvious functions of the brain is the power of speech, and various imperfections of speech denote disease in one or other region of that organ of the mind.

Complete loss of speech is aphasia; but short of this, there is a functional disorder where words can still be spoken, i.e., there is no paralysis, but in which they are all

jumbled up so that they make no sense. The technical term for this is " paraphasia ". In *A Midsummer Night's Dream* (Act V. Sc. 1) we have a *perfect* description of paraphasia—

> " His speech was like a tangled chain ;
> nothing impaired but all disordered ! "

I doubt whether any neurologist to-day could put it more pithily.

We may now close this study of biology in Shakespeare by considering a passage. which in my opinion is one of the most interesting we have yet examined.

It occurs in *Hamlet* (Act I. Sc. 5), that play, according to some critics, the profoundest of them all, where the ghost remarks—

> " The glow-worm shows the matin to be near,
> And 'gins to pale his uneffectual fire : "

Each of these two lines embodies a deep biological truth. First of all, why does the glow-worm show the matin to be near ?

Because the feeble light of the glow-worm, in common with all other lights, begins to appear paler as the dawning daylight increases in intensity. The relatively feeble light emitted by the glow-worm can be seen easily

in the dark because the retina being, as it is called, "dark-adapted", responds readily to very slight illumination, as Pericles says in *Timon of Athens* (Act II. Sc. 3)—

> "Like a glow-worm in the night
> The which hath fire in darkness, none in light."

In a strong light we do not perceive feeble lights; we do not see the stars in the daytime although some of them are there; the moon in the daytime is just visible; in strong sunlight it is so difficult to perceive the flame of a fire that some people firmly believe that the sun is putting the fire out. A candle, quite useful at night, scarcely adds anything to the illumination of a room in the daytime, as indeed Shakespeare says—

> "We waste our lights in vain, like lamps by day."
> (*Romeo and Juliet*, Act I. Sc. 4)

This is only a particular case of a principle of wide-spread occurrence in living matter—namely that a tissue, e.g. the retina, being stimulated and in a state of activity, is insensitive or irresponsive to further stimulation, which incapacity has been called functional or physiological inertia. If the retina is already stimulated by the daylight it will not respond to (perceive) any much

feebler light such as that of a glow-worm. Shakespeare in fact has said as much in *Romeo and Juliet* (Act I. Sc. 2)—

"... one fire burns out another's burning."

But still more interesting is the use here of the word "uneffectual". Why is the light of the glow-worm an uneffectual fire? Because it is light without heat; a light that could not set fire to anything is indeed uneffectual. The light of a glow-worm is a perfectly *cold* light. When you pick up a glow-worm it doesn't burn your fingers in the least. It has lately been ascertained that the light emitted by this creature (Lampyris) is due to an oxidative process (known as chemi-luminescence) whereby chemical energy is transformed into light without having to pass through the intermediate stage of heat. Man has not yet contrived to produce light without heat. Nature did so long long ago, when the light of the first glow-worms and of the fire-flies twinkled in the primeval forest; when the first Noctiluca blazed their trial in the dark ocean as the glistening wave struck the shore of that world millions of years ago.

Light without heat—without wasted heat—is what man ardently desires to have, and may some day discover; up to now he has not produced it. The spectrum of this animal light shows it to be devoid of vibrations both towards the red and towards the violet end: light such as this without the violet or the ultra-violet must be chemically inert, non-actinic and, therefore, once more uneffectual.

I leave you with this splendid example of the amazing insight into living Nature which our and the world's greatest poet possessed.

While one must deprecate anything like uncritical hero-worship in the case of Shakespeare, and while we must not yield to the not very uncommon temptation of reading into certain passages a meaning which it is quite impossible Shakespeare could ever have intended, yet we shall not greatly err if we admit that in the writings of this extraordinary man we find a wealth of observation in the realm of living things which is as extensive as it is penetrating, and which is absolutely unparalleled in the literature of any other country.

The more we understand of what the myriad-minded Shakespeare has observed,

the more we become lost in astonishment at the universality of his genius.

Well did Pope say of him: "Shakespeare seems to have known the world by intuition and to have looked through Nature at one glance".