THE WORLD AND MAN

THE WORLD AND MAN

A Guide to Modern Knowledge

H. E. L. MELLERSH B.Sc.

With decorations and diagrams by
SALLY MELLERSH

HUTCHINSON
Stratford Place
London

Hutchinson & Co. (Publishers) Ltd.
London, New York, Melbourne, Sydney, Cape Town

First published 1952

Printed in Great Britain
by The Anchor Press, Ltd.,
Tiptree, Essex

ACKNOWLEDGMENTS

Though naturally they are not to be held responsible for what I have written, I would like to express my very deep gratitude for the help given to me by my friends: Marjorie Chrighton, B.A.; Dr. L. J. Chubb, M.Sc., Ph.D., F.G.S.; L. H. Collison, M.A.; E. J. R. Heyward, M.Sc. (Econ.); J. Kitchingman; H. J. C. Larwood, M.Sc., M.Ed.; S. C. Laws, M.A., M.Sc.; Yvonne Laws; S. A. Marsh, F.R.C.S., L.R.C.P.; Mary Marsh; Joan Martin; E. L. Mellersh, M.A.; F. Pickbourne; Gordon Russell; G. C. Sadler; J. K. Sadler; K. A. Sadler, B.Sc. (Eng.); Dr. W. H. Scott.

Sincere thanks are also due to the following for permission to quote from the works mentioned:

The literary executors of the late Professor Breasted, and Messrs. Hodder & Stoughton: for the verses from his translation (in *A History of Egypt*) of Akhnaton's "Hymn to the Sun", quoted at the head of Chapter III.

The literary executors of the late Sir Arthur Quiller-Couch and the Cambridge University Press: for the excerpts from *The Art of Writing* in Chapters X and XI.

Mr. Siegfried Sassoon and Messrs. Faber and Faber: for the poem "The General" and part of the poem "Soldiers Are Dreamers All", in Chapter XI.

Mr. Walter de la Mare and Messrs. Faber and Faber: for the poem "An Epitaph" in Chapter XI.

Mr. C. K. Munro: for excerpts from his book *Watching a Play* in Chapter XII.

Dr. Gilbert Murray, O.M., and the Editor of *The Listener*: for excerpts from a broadcast talk quoted in Chapter XXII.

Liverpool. H. E. L. MELLERSH.
1952.

CONTENTS

INTRODUCTION

THE IDEA AND PLAN OF THE BOOK — *Page* 9

PART I

MAN'S ENVIRONMENT

Chapter I	What the World is made of, or The Constitution of Matter. (Chemistry)	15
II	How the World's Matter Behaves. (Physics)	25
III	The World in Space. (Astronomy)	37
IV	The World Itself. (Geology and Geography)	44
V	The Life of the World. (Biology; Evolution)	57

PART II

MAN HIMSELF

VI	The Human Story. (Archaeology and Pre-History)	81
VII	The Human Story—continued. (History)	95
VIII	The Human Body at Work. (Physiology)	107
IX	The Human Mind at Work. (Psychology; Anthropology; Analytical Psychology)	123

PART III

MAN'S ACHIEVEMENTS OR HIS INFLUENCE ON HIS ENVIRONMENT

X	Man, the Talker. (Grammar and the Use of Language)	143
XI	Man, the Weaver of Words. (Literature)	158

XII Man Pretends. (The Play; The Film) 170
XIII Man has Ears. (Music) 178
XIV Man Re-creates. (Painting; Sculpture) 189
XV Man Beautifies. (Other Visual Arts; Design) 198
XVI Man, the Builder. (Architecture) 206
XVII Man, The Calculating Animal. (Mathematics; Statistics) 218
XVIII The Wealth and Welfare of Man. (Economics; Money) 238
XIX The Work of Man. (Descriptive Economics; Production; Commerce) 249
XX The Ruling and Controlling of Man. (Law; "Civics"; Government) 254
XXI Man Conquers Matter. (Electricity; Electronics; Atomic Energy; Relativity) 267
XXII Man Struggles towards Wisdom. (Touching on Philosophy, Logic, Ethics, Semantics, Politics, History, and Religion) 280
Appendix. Some words of Greek Derivation 297
Index 305

INTRODUCTION

THE IDEA AND PLAN OF THE BOOK

NOWADAYS we nearly all have to be specialists in something—and learning to become a specialist often leaves us very little time for anything else.

Yet nobody wants to be so dull, so narrow or so restricted a being as a specialist alone. There is the whole realm of art, the whole world of science; somewhere round the corner, tantalizingly round the corner, are knowledge and understanding—and awareness and appreciation and all that is meant by that overworked and rather forbidding word, culture. This book is written with the specific intent of helping people round the corner.

It is not a science digest—though it does begin with some Chemistry and Physics—nor is it a *vade-mecum* for the solver of quizzes or a help towards one's becoming a walking encyclopaedia. It is a guide. In writing it I have had in mind particularly the young student; but more generally it is meant for all those of any age who, having left their childhood education behind them, have still the desire to go on learning.

I want to stress that. This is a book for the grown-up—whether recently or long grown-up is immaterial. I believe that we can learn differently when we are adult, more easily, more intelligently, more pleasantly; and we can learn in that better way, I hold, just *because* we are grown up.

Consider how we learn as children. We learn by heart; we learn in separate compartments, subject by subject; we have it all drummed into us. And then afterwards we perhaps cry in exasperation: "Why wasn't it explained to me, why wasn't I shown what lay behind it all, why wasn't I told *why*?"

That perhaps is a natural cry. But I believe it is wholly unjustified. We are being unfair to our teachers. We were then too young, we had no background; we were—and who shall blame us?—largely recalcitrant and unco-operative. But *now*? Now it is different. Our brain is a different brain, our experience is wider. In other words, if we want to become decently educated, it is no use repining or slanging our teachers of the past; all we have to do is with some justifiable optimism to start afresh and on a new basis.

There is an operative word here, I think. E. M. Forster uses it in his novel *Howard's End*. A recurring phrase in the book is this: "*Only connect!*" The heroine is a sensitive and understanding sort of person, and she can obey that command. But the other main character—the nearest that the gentle novel gets to a villain, for he has nonetheless sterling virtues—is one to whom that particular virtue is impossible. He is a hard and proud business man, a man who never sees the implications of his actions or, more particularly, of his words on his sensitive hearers, who never appreciates the subtleties of cause and effect, who cannot distinguish the wood from the trees.

Now without being too superior or complacent we can say that, unlike ourselves, that sort of man has never grown up. He can never learn because he will never understand.

If then—to come back to our own immediate problem—it is true that we can only learn if we are able to understand, and can only understand if we "connect", then we must surely have a *plan* for our learning. And not only so, but it must be a plan or framework with interconnecting filaments—lines, we might say, such as cross a map and enable one to pinpoint a position and to find one's way. The rest of this short chapter will be devoted to saying something of the plan of this book and to giving a few examples of those connecting filaments.

Take Geography for instance. Geography connects with Geology—as intimately as a dress connects with the shape of the body beneath it. Then Geology connects with Astronomy—the Earth being but the satellite of a star—and Astronomy in turn with Physics and Chemistry (why did we name a certain element helium?). Or go the other way, Geography to History. Geography *conditions* History—taking the wide enough view. A shift of climate: a shift of population: invasions: wars: "sad stories of the death of kings". History one may look upon—up to a point—as dependent upon Economics, on the hard facts of life; and Economics depends upon what is called Ecology, which concerns itself with the interdependence and the delicate balance of all the forms of life that jostle and occasionally help one another on that thin skin of the Earth which is their home. With that you have reached, quite obviously, Biology.

Yet that is not, by any means, the only kind of connection, from one science to another. This book is naturally—though it is perhaps a point that needs stressing—concerned as much with the arts as with the sciences. Because they are of a different temperament the scientist and the artist often mutually distrust each other. It is a tendency they should guard against, for it surely diminishes them both.

It is true that the sensible artist cannot and does not ignore the science of his own particular technique: the painter knows about light and colour, the musician may well be fascinated by the mathematics of harmony, the writer will certainly need to know what etymology can tell him of the origin and evolution of the tools he uses, which are words. But the connection and mutual enlightenment between the arts and sciences is something much deeper than that. What it comes to is this, that there is no real dividing line between them.

Come back to Biology—and add Anthropology. Those two are perhaps formidable words, but they mean no more than the Science of Life and the Science of Man respectively. The latter certainly needs further defining; by Anthropology is meant usually the enquiry into the life of Man (and in particular Primitive Man) as a *social* animal—his institutions, his customs and his beliefs. Now those two sciences bear on the arts all the way through. How did we acquire an ear for music, an eye for colour, a delight in words? Surely as an evolutionary process, as an adaptation to environment, and—to put it less drily—by the delighted exercise of those supreme birthrights of the Lord of Creation, brain and sensitivity. Think of those early men, in the dim mists of the past, mouthing out their rhythmic noises, dancing before the potent and mystic painting on the firelit wall of their cave, chastising those who broke their taboos. In those processes they were evolving art, language, drama, law, religion. . . .

And no one teaches a child Anthropology! Thank Heavens they do not try. But what a field open to the adult! . . .

We have been brought to a definition of the "framework" of this book. Let us avoid those rather forbidding words of Greek origin ending in "ology" and say that the binding theme of this book is *Life* and *Man*.

After all, what else could it be? It is inevitable. "The proper study of Mankind is Man": that is, or should be, more than a stale platitude. Man, with all other forms of life, has reacted to his environment and in the process is learning to achieve control of it. The three Parts of this book are:

Man's Environment;
Man Himself;
Man's Achievements, or His Influence on His Environment.

That is the Plan. You will see, incidentally, that after each chapter heading there is shown the school (or post-school) subject or subjects that it more or less covers. That is there for convenience only, but no one must let these sub-titles ensnare him into thinking in watertight compartments. There are, as we have already said, no such compartments, there is only a whole.

Keep that idea of a whole, and it will undoubtedly help. For no one is going to pretend that getting a grip of modern knowledge, even as an adult, is something so easy that it does not need application and active intelligence. It is not, by definition, child's-play. One *must* therefore have an outlook—a synthesis, a plan. To attempt to conquer without a plan would be like trying to find one's way across London without the aid of a map or a friendly taxi-driver.

Finally, a plea and two pieces of advice for the reader of this book—all of which will not, I hope, be taken amiss.

The plea is this: that the book be read, as is obviously intended, as a whole. Now for the advice. At the end of each chapter I add a paragraph or two of suggestions for books to be read. On the same lines, therefore, I make two suggestions here: a dictionary, and a small encyclopaedia or biographical dictionary—and these, obviously, to buy rather than to borrow.

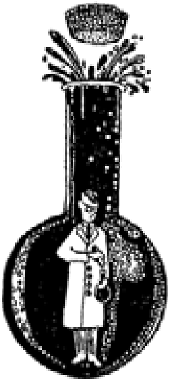
I give this advice—and it is meant perhaps more particularly for the young—both humbly and earnestly because I remember so vividly at what a loss I was myself when first, after a fallow period in the Army of the First World War, I began to read seriously. Who, I asked myself with exasperation, were all these *people* I kept on reading about? Akhnaton and Aristotle, shall we say, Brahma and Burne-Jones, Copernicus and Cortes? Partly it is of course a matter of patience, one will learn in time. And so far as names in literature are concerned there is certainly no short cut: even the person going in for a "General Knowledge" test will do no good by cramming himself with such idiotic lists as "all the Dickens characters and the books they come from". But for historical characters a book of reference is a help.

Words can be as difficult as people. We have an amazing language—a triple language almost, with derivations from Anglo-Saxon, from Latin and from Greek. (The Greek derivations, though fewest, seem to me so important, particularly from the widest scientific angle, that an appendix of the commonest of them is given at the end of this book.) There is only one way to master our language: *use a dictionary*—an etymological one, that is to say one that gives derivations.

The two suggestions for a dictionary and a small encyclopaedia are: *The Concise Oxford Dictionary; Hutchinson's Twentieth Century Encyclopaedia.*

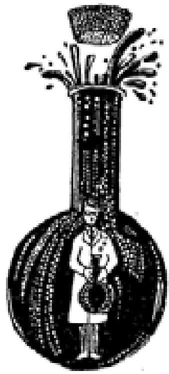
PART ONE

Man's Environment



CHAPTER I

WHAT THE WORLD IS MADE OF OR THE CONSTITUTION OF MATTER



(Chemistry)

THERE must undoubtedly be a very large number of wise, well-educated, well-read people—people in fact upon whom we could legitimately pile all the eulogistic adjectives that we only wish could be with good cause piled upon ourselves—who know virtually nothing about Chemistry. It is hardly one of the Humanities, it is not often regarded as part of culture—why then worry about it?

There are several good answers to that question. It should be enough to say two things: some of the wise perhaps wish that they did know a little more Chemistry; or, if not, then they have reached a state of wisdom and wide outlook by other and not necessarily easier means, and have so got beyond the necessity. But neither of these answers means that we more ordinary, more humble, more aspiring but less established folk do not need to know something of the subject. It does probably mean that unless we want to specialize we can afford to treat the subject only lightly and superficially. This, therefore, will not be a long chapter.

It will not, however, be a very easy chapter—to treat the subject superficially is not the same thing as treating it cavalierly.

The reason we need to know something of Chemistry is simply stated. Firstly, the modern chemist affects our everyday life profoundly; secondly, and more importantly, Chemistry concerns the fundamental make-up of the material world about us, it is quite definitely the beginning and background of what we have set ourselves to examine in Part I of this book, Man's Environment. We shall not understand so well or so easily other and perhaps more humanly interesting chapters if we do not know a little about Chemistry.

For many of us, Chemistry at school meant the meaningless footling around with test tubes and Bunsen burners and incomprehensible pieces of glass piping, interspersed with dull and solemn notes about experiments which either didn't seem to have succeeded or else were too obvious to need any notice being taken of them at all. For a few of us perhaps, it was merely light, or even comic, relief. If that was so, it is unfair and thoughtless to blame our schoolmasters—the fault was almost certainly ours.

Chemistry is concerned with the constitution of matter, with how the different kinds of matter combine, divide, change, react on one another, and with what happens when they do it.

What do we mean by "matter"? The classic definition is, "that which occupies space". We might say, the stuff this world is made of in all its forms.

And, you may well exclaim, how many and varied are those forms! What connection, what similarity, have a stone and a jellyfish, a flower and a tin-opener, air and an elephant, a bit of mud and—me? On the face of it, not much. But here is a problem which has worried mankind for very many generations, almost since he began to think clearly. Surely, people have said, there is some fundamental sameness about matter, about all the different kinds of things, animate and inanimate, in this world of ours. Surely there is some common denominator! All sorts of different buildings are made of the same thing, bricks; is there not then, in the same way, some "brick" from which all matter is made if we could only discover it, some infinitesimally small thing, down beyond which you cannot analyse or divide any single kind of matter? The Greeks, over two thousand years ago, said there must be such a thing and gave it a name, the Atom—A-tom, something that can't be cut or divided any further. They were on the right track.

But it is one thing to be on the right track, or to make a brilliant guess, and another to put forward a definite theory that can be subjected to scientific test. This was left to John Dalton, a quiet, kindly, comfortable Quaker teaching in a school in Manchester at the turn of the eighteenth century.

But before we set down John Dalton's propositions, we need a word of explanation.

All substances, says Chemistry, can be divided into three classes: *Elements*, *Compounds*, and *Mixtures*. An element is a substance which can*not* be decomposed into two or more substances. A compound is composed of two or more elements held firmly together by a force—an inherent and inexplicable force—called chemical attraction. A mixture is composed of two or more ingredients (either elements or compounds) which can be separated by merely mechanical means.

Those three definitions need getting into one's head. And to make clearer the difference between a compound and a mixture we will give a simple example.

You could take iron filings and powdered sulphur and shake them well together. The result would be a Mixture. It *looks* something different: greyish instead of yellow and near-black. But that is the only change.

But now heat some of the mixture in a test tube. Something much more definite happens: a glowing red spot appears which goes on glowing even when the tube is taken out of the flame. And when it is cool there has been created something quite different, a lump which under the most powerful lens will never show any separate particles of iron and sulphur. A mixture is man-made; but here we have a Compound, formed by means of this force of chemical attraction. And if you ask just what is this force and why, even the chemist cannot answer you. It just *is*. Chemistry—indeed Science—is, we appreciate, like that. The scientist observes, worries out, enunciates the deep, unalterable facts and properties of the Universe we live in. In the process, he enables us more and more to understand and control that Universe. But in explaining just *why*, Science has not got very far—and probably can never get all the way.

Back to John Dalton. He propounded the following "laws":

(i) That all matter is composed of atoms;
(ii) That atoms are indivisible, and that they cannot be destroyed or created;
(iii) That all the atoms of the same element are *exactly* alike, but different from the atoms of all other elements;
(iv) That chemical compounds are formed by the union of small *whole numbers* of atoms of different elements; and
(v) That the smallest particles, or "compound atoms", of any particular compound are all exactly alike, but different from the "compound atoms" of all others.

That, too, can with advantage be read twice and thought about.

There are two alterations we should make nowadays to these five axioms. One is that we call Dalton's "compound atoms" *molecules*, merely another name. The second is more fundamental; it concerns the second part of axiom (ii), that atoms cannot be destroyed. Splitting the atom—or, to be more scientific, nuclear fission—has altered all that.

It is so significant an alteration that we leave it until the last chapter but one of this book.

Dalton had not enunciated his propositions from guesswork but from his observations of how chemicals behaved in their reactions and their powers of combining. They obeyed, in fact, certain *laws*, and they did so because all the atoms of any element are alike and one element differs from every other element simply because its atoms are different. The *structure* of its atoms is different.

What is the structure of an atom like? We cannot know from seeing it, for the simple but staggering fact that a pin's head of matter will contain something in the neighbourhood of a thousand million million million million of them.

In fact, it really goes deeper than that: no microscope* is ever going to *see* into what is happening within an atom because what is happening there is itself the cause and source of light; it would be a little like trying to see how moving pictures move by stopping the projector. Nevertheless, by the most ingenious and brilliant experiments much has been learnt about the structure of the atom.

Briefly, the atom is envisaged as essentially a central core or *nucleus*, around which gyrate a varying number of even smaller particles called *electrons*.

And here we must at once issue a warning: it is not very helpful but it is necessary. We say "envisage"; we might even say "imagine". For we are now in a world which Mathematics describes much better than words. And yet words must needs try to do the job for the non-mathematician. Is it right to describe the electron as matter at all? Or is it, rather, electricity? Or both? Or vibrations in the Ether? We cannot say. None of the descriptions of atomic structure and behaviour must we take too literally; sometimes it would be better were the words "as if" added to the description. Those billiard-ball diagrams of atoms and molecules that one sees in text-books: do not forget that they are only "as if"; remember that they are no more than helpful approximations. Remember too that not a thousand thousand bottles of Alice's "Drink Me" medicine would make you small enough to inhabit this new Wonderland of the Physicist.

With that warning behind us, however, much can be said that is useful.

Hamlet, in one of his many moods of depression, wished that his too, too solid flesh would melt; when we hit ourselves against anything we may also feel that matter as a whole is all too solid. But not so

* Not even the electron microscope; though this, making use of much shorter wave-lengths than those of light, enables us to photograph (though not see direct) things a hundred times smaller than before.

the chemist and physicist. To them the infinitesimal atom is a vast emptiness about which gyrate a few even more infinitesimal particles (or electric charges?) as sparsely—as one expressive scientist put it—as "flies in a cathedral". Yet certainly not so aimlessly: the *microcosm* of the atom is remarkably like the *macrocosm* (see etymological dictionary) of our own planetary system where the Earth and Mars and the rest revolve round the sun in utter immensities of space. In the atom the nucleus is the equivalent of the sun and the circling electrons are the equivalent of the planets.

Now, as chemists, we can get on to something firm. What it is that distinguishes one atom from another, and so (as we have learnt from Dalton) one element from another, is *the number of electrons which are revolving round the nucleus.*

Hydrogen is the simplest and lightest element, and has but one electron; it is used as the standard against which all other elements are measured and compared. There are—so far as is known at present—and apart from man-made additions through the medium of nuclear fission—ninety-one other elements, each with one more revolving electron than the one before.

All of them have names—though many of them have never been seen except by the experimental chemist—and all of them have Symbols.

It is to John Dalton, too, that we owe the idea of using symbols in Chemistry, an idea for simplicity and the saving of time. Instead of hydrogen, we say "H"; for oxygen "O". Thus water, a compound, each molecule of which is composed of two atoms of hydrogen and one of oxygen, has the "formula" H_2O. Sometimes the symbol comes from the Latin for the element, such as Cu for copper (cuprum) or Ag for silver (Argentum). Here is a list, in alphabetical order, of some of the more common of the 92 elements. But in reading them do not forget this: that in chemical formulae and equations the symbol does not stand for the element only, but always for *one atom* of the element.

Element	*Symbol*
Aluminium	Al.
Antimony	Sb.
Argon	A.
Bismuth	Bi.
Calcium	Ca.
Carbon	C.
Copper	Cu.
Gold	Au.
Helium	He.

Element	*Symbol*
Hydrogen	H.
Iodine	I.
Iron	Fe.
Lead	Pb.
Magnesium	Mg.
Mercury	Hg.
Nitrogen	N.
Oxygen	O.
Phosphorus	P.
Potassium	K.
Radium	Ra.
Silver	Ag.
Sodium	Na.
Sulphur	S.
Uranium	U.
Zinc	Zn.

A few of the elements no scientist has yet discovered; but we know they exist. Many recent discoveries are metals, and these all end in "-ium". All the metals are of course elements—bronze and brass not being exceptions but mixtures or "alloys" (copper with tin, and copper with zinc respectively).

So far we have confined ourselves almost entirely to elements and have mentioned only one compound: H_2O, the formula for water. These formulae for compounds show, one might say, how elements go about together. One might almost say, how elements *like* going about together. For they have very definite preferences in this matter. If one imagines the atoms as little balls, then it is almost as if these balls had different numbers of sticky places where, in this queer business of chemical combination to form a compound, other balls *can* become attached. Hydrogen would have only one such sticky place, oxygen two, carbon four, and so on. This brings in a new word, which is well worth remembering: *valency*. Valency describes the powers-of-combining possessed by the elements. Since hydrogen's valency is one and oxygen's two, you can see why water, if it is made of those two elements, has that formula H_2O and no other. Indeed if we like to imagine the oxygen atom as a flirt, arm in arm with a hydrogen suitor on each side, and if we were a little more alive to inventing new sayings and similes instead of using out-of-date ones, we might—conceivably—even talk about "two hydrogens to her oxygen" instead of "two strings to her bow".

There is another curious preference: the atoms of most elements seem to hate going about on their own even when there is no other element with which to combine. Oxygen is indeed one such—in love with itself (if we may dare to carry the simile a little further) when there is no other lover handy. Yet the oxygen atom can be made to go about not in pairs but in triplets; and this is done by what we may for simplicity's sake call an electric shock. Then we have not O_2 but O_3; and O_3 is Ozone. Ozone is produced in a thunderstorm, a natural electric shock: and somebody as distant and unlikely as Homer noticed the distinctive smell of ozone after a storm—though he certainly did not call it an *allotrope* of oxygen, which is what the scientist calls it now, even though that word is a Greek one.

The extraordinary thing about ozone is that except in very small doses it is poisonous and so very different from the life-giving oxygen. Why this is, nobody can yet tell you. In the same way the soft, lubricating graphite and that hardest of all things, a diamond, are each an allotrope of carbon. Here, the different way the atoms arrange themselves creates a different crystalline formation. Do not, incidentally, confuse allotropes, caused by differences in atom-grouping, with *isotopes*, which are the result of differences in atomic structure. They will come in the penultimate chapter.

What we will do now is to take some of the familiar and everyday chemical terms and try to explain them, and their significance, as concisely as possible. What exactly is an acid, for instance, and an oxide, and a salt, and a catalyst?

Take an *acid* first. It is curious how in Nature a few of the elements are of absolutely paramount and outstanding importance: there is no reasoned explanation, that is how the Universe is made. Hydrogen is one of these, structurally, as we have said, the simplest element; it comes into the picture now.

Put as simply as possible, it is this: no hydrogen, no acid. An acid turns blue litmus paper pink (which does not get us very far), and always tastes sour. But, what is more revealing, an acid always contains hydrogen and can be prevailed upon fairly easily, in combination with a metal, to give up all or some of its hydrogen, doing something rather drastic in the process. What happens is a "chemical action": hydrogen escapes, some of the metal takes its place, and the result is—a *salt*. Which conveniently gives us the definition of a salt: "the resultant of the chemical action of an acid on a metal".

We will give here our only practical example. "Take", as the text-books say, copper and sulphuric acid, and heat them together. A chemical action follows which is represented by the equation:

$$Cu + 2H_2SO_4 = CuSO_4 + 2H_2O + SO_2$$

which means that (several million times over) one atom of copper and two of molecules of sulphuric acid have turned into one molecule of copper sulphate, two molecules of water, and one of sulphur dioxide. Which at least goes to show that chemical equations and formulae are not incomprehensible hieroglyphics, the esoteric language of a mad scientific priesthood, but a convenient and simple way of using Dalton's symbols to state what has happened.

The salt in the above equation is $CuSO_4$, copper sulphate. All the *-ates* are salts: nitrates, carbonates, bicarbonates and the rest. In our world salts are in fact the most everyday affairs. (One is so common that we merely call it "salt": NaCl, Sodium Chloride.) They are also important because they exist in a form which living substances can absorb. For health, indeed for existence at all, we need traces of many metals in our body, iron above all. But obviously, to satisfy that need, we do not swallow a couple of nails. Our doctor, when we are anaemic, probably gives us a tonic with iron sulphate in it. In the same way, farmers put nitrates and potassium sulphate into the ground for the absorption by, and benefit of, the crops—the chemist having helped by discovering easy processes for obtaining them.

Which brings us to oxides, and to catalysts, and so to the most difficult piece of real factual chemistry we shall attempt in this chapter.

Oxygen has the property of combining very easily with many elements to form *oxides*. Think how easily rust forms: that is iron oxide, using the oxygen of the air. If you want to intimate that one atom only of oxygen has combined to form the molecule of a new compound, you call it a monoxide; two, a dioxide. Yet this difference of one atom can have very great significance: you and I breathe out innocuously carbon dioxide, but a motor-car expels carbon monoxide, which has been found at times a simple means of suicide.

Now some oxides can do a very surprising and a very useful thing. They can *hurry up* a chemical process without in any way being affected themselves. You can, for instance, obtain oxygen by heating potassium chlorate. But if you add manganese dioxide, you get the oxygen much more readily, the dioxide nevertheless remaining quite unaltered. *That* is a *catalyst*. If you do not remember the details, remember the idea and the word; it is often used metaphorically: something that produces or speeds up an effect without being in any way altered itself—a little like, one might say, the oil in a machine.

We spoke, some pages back, of a few elements being of paramount importance in the scheme of things. Besides hydrogen, there are carbon, nitrogen and oxygen.

Carbon is an element in all living matter. It turns up always, and it turns up in most complicated forms. It was perhaps a bold man who first argued that, if all inanimate nature could be resolved into chemical compounds with chemical formulae, then equally so could all living substances. But it is of course true. Yet how difficult to arrive at, and how involved when obtained! Ordinary cane sugar is $C_{12}H_{22}O_{11}$, for instance, and an acid from animal fat is $C_{17}H_{35}COOH$. What matters in these living substances—and a whole separate branch of Chemistry, called Organic Chemistry, deals with them—is not so much the elements concerned as the *pattern* of the molecules made up by those elements. Those patterns are of infinite variety: we shall, incidentally, meet the idea of "pattern" in Nature, both animate and inanimate, quite often in this book.

Nitrogen, too, appears very often in the chemical formula of living substances. It is also the main constituent of the mixture we call air. Air has traces of such unexpected gases as Argon, Neon and Helium, and about 1% of the carbon dioxide that we and animals and plants breathe out. The other 99% or thereabouts is nitrogen and oxygen in roughly the proportion of four to one.

And if carbon appears in all living matter, oxygen is even more important in that without it life just cannot exist. (Or, rather, we should say "life as we know it", which is what the astronomer always says in talking about those other planets which have no air. It might be more helpful to say "life except as we cannot possibly begin to imagine it".)

Oxygen makes *life* possible. Oxygen makes *fire* possible. There is no explaining it—again it just is so. When we breathe we consume oxygen. A flame consumes oxygen too. And both processes are called combustion and are basically the same. About that, however, we shall learn later in the chapters on Physics and Physiology. Combustion was certainly a thing about which mankind in general took a long time to learn. Things burnt, people held, not because of something in the air which burning took out of the air, but because of some property which on the other hand the air took out of *it*. *Phlogiston*, they called this property, the Greek for flame, and wrote tremendously about it. It took an English Noncomformist parson, Joseph Priestley, and a Frenchman, Lavoisier, to discover oxygen and to propound the correct theory respectively. And that was as recently as the end of the eighteenth century; and even so Priestley—aptly but certainly not justly—got his house burnt down by a scandalized rabble for his presumption and his pains. . . .

That is as far as we will take Chemistry. It is sketchy enough. But, at the very least, one idea we must lay firm hold upon to help us in later chapters. It is this: the importance of the atom and of the structure and behaviour of the atom. *That* is what governs the constitution of matter, whether it is simple or compound, organic or inorganic. As we shall learn later, it governs a good deal else as well.

The rest of chemistry in all its complication we leave to the expert. At least, however, let us appreciate a little how profoundly that expert affects our material lives. We do not have to think very far : the making of soaps and of soap substitutes ; the changing of unpalatable fish oil and whale oil into margarine ; the whole of the cellulose, artificial silk and nylon industries ; dyes, plastics ; food preservation ; vitamins ; antiseptics ; anaesthetics and drugs ; pest destruction (the tsetse fly, for instance) ; artificial fertilizers. There are some who say that we have gone too far, too far away from Nature, in our use of chemical fertilizers ; but that is rather to show that we should use our chemical discoveries with intelligence and discrimination than that we should not use them at all. A less obvious but even more important thing is the debt of metallurgy to the chemist and of humanity to metallurgy. Those prehistoric discoverers of tin and copper and bronze, and their successor the discoverer of iron, might be called early chemists—people who, perhaps more by luck than good judgment, discovered how to turn the ores and oxides which abound in Nature into the good, hard, but malleable and castable metals which we know and use so much. The much later successors who found out how to make steel by introducing traces of carbon into molten iron, and then how to make even harder steels by combining cobalt and nickel and magnesium, influenced history even more. Whether or not it will prove a good influence is at any rate a matter which does not come under Chemistry. . . .

BOOKS : Many text-books on Chemistry are of little use to the beginner or self-educator, just because they are written round a series of practical experiments, which of course bring things home to you if you happen to be in a position to do them or to have them done for you and explained to you by lecturer or teacher. But a book which will help without your having this advantage is *Junior Chemistry*, by E. J. Holmyard (published by J. M. Dent and Sons Ltd. in 1933 in their Modern Science series). Another is *Teach Yourself Chemistry*, in the English University Press series of that name. Another book into which you can at least usefully dip is *Chemistry in Modern Life*, by the Swedish Nobel prize winner, S. A. Arrhenius (Chapman & Hall, 1926). That will help to bring Chemistry to life for you and to make you realize how Man in both his arts and his sciences—the lovely perfume and the beautiful porcelain bowl, as well as the dye and the drug and the machine tool—is indebted to all those who have prised out from a reluctant Nature her secrets of the Constitution of Matter.

CHAPTER II

HOW THE WORLD'S MATTER BEHAVES

(Physics)

IF Chemistry is concerned with the Constitution of Matter, Physics may be said to deal with the Behaviour of Matter.

It answers, or tries to answer, the age-long puzzled query of small men on this large earth, "What happens *when*——?" What is really happening when the lightning strikes or the rainbow appears, when we call and there comes an echo, when we fall and the ground appears to come up and hit us?

Primitive men seem really to have thought that the ground came up and hit them, and were angry, like little children. They heard the backwash of their own voices and personified it and called it Echo, and invented a pretty story of a youth bewitched and perpetually doomed to answer the call of his lover. They saw the rainbow after the flood, and invented an even more beautiful story.

But those stories, however beautiful, are very obviously not the whole truth. And if we are to control Nature, to use her and not be afraid of her, we need surely to know the whole truth—or as near to it as we can get.

Science means, literally, Knowing or Knowledge; and the science of Physics has probably added more than any other in recent years to our knowledge. How do air and other gases behave, how does water, how do things-in-motion behave, how do heat, light and sound, and—rather obviously of increasing importance—how does the atom behave? Those are some of the questions which Physics tries to answer. It says that there are *laws* governing these behaviours, not man-made laws, but laws of God or Nature (whichever it is your preference to call them) and man-discovered.

In the course of time men may find that they have not yet discovered these laws correctly and will amend them, as Einstein has amended Newton. They are not, then, as immutable as the Medes and Persians at least pretended theirs to be. But they serve well enough.

Physics is a large, amorphous, and a growing subject. It touches, or is touched by, mathematics, engineering, chemistry, the theory of music. The text-books divide themselves into such sub-subjects as Mechanics (roughly, all about motion), Molecular Physics, Atomic Physics, and that familiar trinity, "Heat-Light-and-Sound". Quite definitely, a lot of Physics is specialized knowledge; we can leave it to the specialist. We shall browse round, therefore, trying to pick out only the ideas and concepts and terms which we meet in everyday life and reasonably informed conversation, and which seem necessary for a not too ignorant view of the material world. All too much, perhaps, the Physicist in this century shapes our lives; we must not, therefore, be too passive and ignorant in the matter.

The teaching of Physics usually starts with *Measurement*. That sounds unrelievedly dull; we may have childhood memories of its being undoubtedly dull. But Measurement *is* necessary—it is often, and rightly, explained to be the whole basis of Science—and it will not be merely a sentimental attempt on our part to arouse interest if we say that it can even be romantic.

The well-known story of Archimedes is romantic. Archimedes was a Greek of Syracuse in Sicily, living in the third century B.C., that is to say after the time of Alexander the Great and when the town that that great young man founded, Alexandria, was in its heyday of intellectual activity. Archimedes was killed by a fool of a Roman soldier who found him being annoyingly thoughtful.

A man called Heiro was king of Syracuse; and Heiro had a golden crown and rather suspected that the workmen had not used in its making all the gold with which they had been supplied. But how to prove it? The job was handed over to Archimedes.

Now Archimedes knew the weight and volume of the gold supplied. He also knew that the crown weighed just as much as the gold—the suspected workmen were clever enough for that. If, then, he could prove that the *volume* of the crown was different from the volume of the gold supplied, then he had convicted the workmen. But how measure the volume of a thing of such a complicated shape as a crown?

Archimedes, the story goes, stepped into a full bath. It overflowed. Suddenly the truth flashed upon him: the volume of the water that overflowed or was "displaced" (which was easily measurable because it would go into any simple shape you liked) was the volume of that part of him—and similarly of anything else—that was immersed. He got out of his bath and ran down the street shouting "*Eureka!*"—I have found it!—and no doubt shocked the people of that time and place considerably less than he would the modern inhabitants of Balham or Bootle. He then demonstrated in front of King Heiro by dipping, from a thread, first the right weight of gold and then the crown into a full vase of water: the crown, though it weighed no more, displaced more water. And as a tailpiece to that story, the modern vessel specially constructed to make easy use of the "Principle" based on this discovery by Archimedes is at this day called a Eureka Can.

Even the measurement of a straight line can have its significance and romance. You remember the Lavoisier of the chapter on Chemistry. He was guillotined by the French revolutionists—because, they said, "the Republic has no need for scientists". (Hitler made something of the same mistake.) But then they suddenly became more sensible and scientific themselves. Let us cut adrift, they said, from the old primitive measures, a "foot" from the length of a man's foot (rather a big man?), a cubit which is a man's forearm. We will start afresh, they said, and use the *decimal* system, where you always multiply or divide by ten and do it by simply adding or taking away a *nought* (more of this in the chapter on Mathematics). Further, we will build up from fundamental things. A metre shall be a certain small fraction of the earth's circumference (they liked to think grandly), one ten-millionth of a quarter of it in fact; a centimetre shall be a hundredth of a metre, and so forth. And then weights, they said, shall be connected with the volume of that ubiquitous thing water, and a gram (or gramme) shall be the weight of a cubic centimetre of the stuff at its temperature of greatest density. The revolutionists did well there. . . .

All that is relatively simple. Let us now have a look at Dynamics; let us try to understand things like *inertia*, *force*, *gravity* and *mass*, *weight* and *energy*. Pretty stories will not help us here; we must get down to it.

Inertia is a word we use in ordinary talk; we mean, roughly, laziness, disinclination to move. But in Physics a moving thing has inertia too: its disinclination is to change either its speed or its direction. And a thing will only change its speed or its direction if a force is applied. Does that mean that if no force is applied to a moving object it just goes on and on in the same direction for ever? Of course it does! The only thing that makes this seem extraordinary is that in ordinary Nature there *is* some force—friction being, of course, the most obvious. A stone over ice at least gives you an idea of motion continuing.

Now, though it is fairly obvious that force is needed to start a thing or slow it down, it is not quite so obvious that a force is always needed to change a moving thing's direction. But think of a motor-car rounding a bend. The passengers, who don't experience a force on themselves, sway in the direction in which the car *was* going, while the car's tyres, by their friction with the road, or the road itself if it is banked, take the strain.

Then think of David's sling. Directly the stone was released it went off in the direction it was travelling in at the moment; it went off "at a tangent" to the circle it was previously describing, and with a very considerable force. Before it went off, it was being *made* to go round in a circle, or to put it another way, it was being made to *change its direction* all the time. David's hand and arm exerted a force on it, and it in its turn exerted a force in its effort to get away. What it exerted is called *centrifugal* force. All that illustrates incidentally the old tag "to every action there is an equal and opposite reaction"—which is what you realize when you plant your heel against the wainscoting when you want to move a heavy piece of furniture and what the petulant child doesn't realize when he tries to make the train go by pushing against the carriage wall.

It should also make reasonably plain the idea of the gyroscope. Here the force exerted all the time by the heavy horizontally spinning wheel is great enough to counteract all other forces, the force of gravity tending to make the top or the monorail car to fall on its side, or the buffeting of the wind that tries to send an aeroplane off its course.

"The Force of Gravity": just what is that? Simply the power which the Earth possesses to attract everything else to it. And that is merely a particular example of the truly astounding fact that everything attracts everything else all the time. It does it in proportion to its mass and in inverse proportion to the square of the distance—which explains why the Earth's pull masks everything else for us: it is so near and so big. It took a genius, Sir Isaac Newton, to discover and enunciate the law and to explain the movements of the planets by it.*

Mass is the next thing we have mentioned. Did confusion between mass and weight perhaps worry you at school? It is very simple really. There is no difficulty about Mass. It is just the amount of matter in anything, its "heaviness". But *not* its weight, that is the point. *Weight on this Earth is the attribute given to mass by the pull of the Earth.* And since that pull varies with the mass and distance of the puller, then weight will vary down a mine or up in an aeroplane. It will vary still

* If you want to know what a genius may be like and in particular what Newton may have been like, read Bernard Shaw's play, *In Good King Charles's Golden Days.*

more if you get into a space-ship and travel to, say, the moon. Indeed, there will be a point when pull of Earth and moon will be equal and you in your space-ship will be weightless and will bounce about most uncomfortably like a balloon. Which brings in H. G. Wells, and his Martians, who found themselves by comparison so lumberingly heavy on this large Earth that only their mechanical ingenuity enabled them to move at all. We on Mars would skip like young gazelles. . . .

Now Physics has her formulae and equations no less than Chemistry, though they seldom look so formidable. Mass in Physics is designated "m". And Force is, less obviously, dubbed "P", and acceleration is shown as "f". We can then give one elementary equation:

$$P = mf,$$

which is a very simple way of stating a not so very obvious truth. It is not, we have learnt, speed or velocity which is an indication of force, but *change* of speed—which is called acceleration. (In ordinary talk we say ac- and de- celeration, but the physicist simply talks of acceleration, plus or minus.) What this equation states is that the force needed for speeding up or slowing down anything equals the mass of the thing concerned *multiplied* by the acceleration. In other words, it will depend not only on how solid is the thing but the rapidity with which the speeding up or slowing down process is effected. When the lorry hits the brick wall the deceleration is so rapid that the damage done is appalling.

You can get another truth from this formula, when you think of that particular acceleration—given usually the symbol "g"—which is caused by the Earth's force of gravity. True that a heavier thing hits the ground with more force. But the greater force is in proportion to the greater mass; the acceleration is the same. Galileo (*d.* 1642) demonstrated this to his sceptical fellow citizens of Pisa, by taking them up its conveniently sloping tower and dropping from it two unequal weights —which arrived together. Place upon a penny a perfectly flat piece of paper of slightly smaller size (to avoid air resistance) and you can demonstrate the same experiment to yourself.

Finally, before we leave Dynamics, and very briefly, three other concepts: *Energy*, *Work* and *Power*.

A thing is said—rather obviously perhaps—to have "potential" energy when it has been given ability to move or to work by virtue of its position: the coiled spring that can "go off", or the lifted weight that can drop. When, on the other hand, action does take place you talk of "kinetic" energy, which is energy of movement (the same Greek word as in Cinema).

"Work" is done when you store up or let loose that energy: coiling the spring or dropping the weight. "Power" brings in the time element, doing so much work in a certain time. And just as the first motor-cars copied the carriage, so the obvious way to measure mechanical power seemed to be against the horse. One Horse Power—and it would be a fairly strong horse—can raise 550 lb. against gravity through a distance of one foot in one second.

Now there are two famous Laws of Physics, the conservation of Matter and the conservation of Energy. Put very colloquially, they are both saying the same thing—*you can't get something out of nothing*. That should be fairly obvious; but we shall find need to remind ourselves of it quite often. It has always been the dream of Man to create "perpetual motion", to cheat Nature in some way and to produce a machine that somehow does give that something for nothing. But it can't be done; the machine does not create energy, it only makes it available. Burn matter, explode matter, do what you like; but the matter is still there—somewhere. Set your ingenious machine to work—but the energy it puts forth always has been put into it. . . . At least so said the Physicists until the Atomic Age. Now they say something different. But it is not a contradiction of the two laws; it is an amalgamation—again as we shall see in the last chapter but one of this book.

Turn now to Molecular Physics. The name we meet here is Brown: a nineteenth-century botanist who found in the world of the very small a "movement" perhaps more surprising than any found in all the immensities of astronomy.

One of Brown's experiments was to pass a strong beam of light through a glass jar filled with air and a little smoke, and to look down on it through the microscope. The particles of smoke were seen to be darting about erratically, never still for long, never ceasing their motion. It was as if they were all the time being hit at random by other invisible particles.

In fact they *were* being so hit. The only possible explanation of this "Brownian Movement" is that the smoke particles are being bombarded by the molecules of the air, which are themselves in perpetual and erratic motion. Further, this activity *always increases with a rise of temperature*.

Now this invisible molecular movement can explain a number of things.

Firstly, what are the differences between a gas, a liquid, and a solid?

That needs thinking about. Why on earth should there be such a thing as gas at all? Why should one set of things, like oxygen, or air, or, say, marsh gas (which is the same as the dangerous "coal damp" in mines)—why should such things be invisible, resistless, unholdable, needing an effort of the imagination even to realize that they are there at all (until lack of them, or a lighted match, as the case may be, makes them only too important)? And then, why should another type of thing *flow*? Why should the third type be as solid and resistant as a lump of steel or the brick wall that that lorry came up against? It is not enough to say that their atoms or molecules are different.

No; it is certainly more than that. It is, rather, that their molecules are in a different *state* and are behaving differently.

Molecules attract one another just as everything else, worlds included, attract one another. Now, in a gas the molecules are very, very widely spaced. They are so widely spaced that to all intents and purposes they do not attract one another. Nevertheless they are all the time suffering from that Brownian movement—infinitesimal but indefatigable dance addicts. They therefore fly outwards—thus causing a *pressure*, about which we shall have more to say in a moment.

In a liquid the molecules are near enough to attract one another, but at the same time free to move amongst themselves. Hence a liquid can flow to fill the shape of its container, but it cannot expand in all directions like a gas: the molecules have only a measure of freedom, they cannot escape. Thirdly, in a solid the molecules are so restricted and anchored that they can move only within very narrow limits, a to-and-fro oscillation rather like a boat at anchor in the tide—and the movement, of course, is so infinitesimal as never to be apparent to the human eye.

But do not forget that fact that the Brownian dance of the molecules grows more hectic and intense with the application of heat. There is a connection there. When water turns to a gas or vapour (steam) the molecules have, as it were, liberated themselves into the first state, of greatest freedom. When water freezes into ice, they are chilled and petrified into the third state of most captivity. And do not forget, too, that water is not the only thing that has these three states. All other elements and compounds have it too—though not necessarily within temperatures which we earth-bound humans can command.

Come back to that idea of the pressure of gases. It is realization by clever men of this pressure and its significance that has given us our pumps and our engines. Robert Boyle, the son of a seventeenth-century Irish nobleman—and in his beautiful curled wig he looks much more like that than one's idea of a scientist—experimented first with a blown-up sheep's bladder. Finally he enunciated the law which still holds his name: that the volume of a fixed mass of gas kept at one uniform temperature varies inversely with the pressure. Which in unscientific language says that, so long as you don't excite the molecules with heat, then if you squeeze a gas into a smaller space it will exert correspondingly more pressure.

Now Boyle also said this: "The generality of men are so accustomed to judge of things by their senses that because air is invisible they ascribe but little to it, and think of it as but one remove from nothing." And even nowadays, though we should know better, it is only too easy to fail to appreciate the importance, the ubiquity and the profound influence of that mixture of gases in which we live and have our being. Air has pressure, air has weight. So much air is piled above us that at sea level there is nearly fifteen pounds weight of it on every square inch of surface (varying slightly, of course, as we shall learn later and as we measure by the barometer). Being a gas it exerts pressure in all directions: it sticks fast the piece of paper against the upturned glass of water in the schoolboy's experiment; it upholds the aeroplane, because we drive that aeroplane forward and we so shape its wings that the pressure is lifted from the upper surface of them. It controls, too, the boiling point of water (or the temperature at which the excited molecules are allowed to escape)—and how convenient a temperature that is we only realize when we climb to the rarefied atmosphere of a high mountain and cannot get even an egg to cook. It conditions the make-up of our bodies, just as the terrific pressure of the deep seas conditions the bodies of the strange creatures who live in its dark depths. Air pressure, like the poor, we have always with us—and we notice it as little.

Much else that is curious is caused by that mutual attraction and hidden microscopic motion of the molecules. There is the "surface tension" of water, which enables some insects to skate upon it as if it were a solid. There is "capillary attraction"—which the plant makes use of to get itself a drink, and the Bradford merchant to make a waterproof.

But one basic idea about molecules you must fully appreciate; it will have significance in the chapter on physiology. It is this: that when you heat a thing you increase the activity or the *energy* of its molecules. Heat and energy are in fact interchangeable; they are aspects of one another.

We will finish this chapter with a little, a very little, on "Heat, Light and Sound". That is the title, grim and monosyllabic, of many a text-book. Such books cover an immense amount of knowledge and hard facts. They also cover—or, rather, hide (since poetic feeling will not help you to pass technical examinations)—a vast amount of wonder and interest and beauty. The two aspects are not really incompatible.

We shall take this trilogy in the order of Sound, Heat, Light.

The first thing to appreciate is that all three are wholly or largely propagated in the form of *waves*. And the next thing, equally important, is that *Sound* is different from the other two: its waves are waves in matter (usually the air); the others are waves in—what? We are not sure. We call it Ether.

We all know, from dropping a stone in water and watching the fallen leaf bob up and down as the ripple reaches it yet otherwise remain stationary, that when waves disturb a medium that medium itself does not travel. But the analogy of water waves and sound waves must not be carried too far. In water the wave is on the surface. Sound waves quite obviously go out in all directions; it is better to think of them as rapidly expanding shells, of alternate pressure and let-up of pressure, pulsing through the air. And the pulsing of course—there is nothing mysterious about it—is caused by actual, physical, vibration. In the plucked harp or cello string, or the rapped tuning fork, you can *see* it; put your finger on it, and you can feel it. It is not altogether fanciful to say that the air feels it too.

It "feels" it and passes it on at the rate—varying a little with the state of the atmosphere—of about 1100 feet, something under a quarter of a mile, a second. Why that speed particularly, nobody can tell you: that is the *nature* of our atmosphere.

When we think of sound in terms of waves or pulses in the air, that we should have echoes as we have backwash from a sea wall, and that one thing should set another vibrating, seem only natural. Our own ear-drum is of course set vibrating in the same way. That we "hear" is simply a way of saying that as a form of life we have learnt to respond sensitively to a phenomenon of nature, the phenomenon of air vibrations. Nor for that matter have we learnt to do so perfectly or completely; apparently there was no need. It is common knowledge that there are sound waves both too slow and too rapid for us to hear.

There are sounds, too, that we hate and sounds that delight us. But that, you may say, is not science but art, the art of music. Indeed it is. But then here is a good example of where art and science meet and help each other. Few notes are simple notes, but rather a complicated harmonic progression of notes in ascending scale but diminishing intensity. The musician needs in fact to be something of a physicist and mathematician as well. He needs, too, the services of the scientist: the "acoustic expert" who will give scope for the resounding waves from his organ to go reverberating up to the cathedral roof or for the subtleties of his orchestra to be neither dulled nor jumbled in the concert hall.

Secondly, *Heat*. Heat, unlike the other two, is not propagated solely by means of waves. *That* the merest baby learns usually by bitter experience. The text-book puts it that heat passes in three ways, by conduction, by convection, by radiation. The first is by flowing along the hot thing itself or the thing touching it; and the second is by the surrounding "medium" moving off when heated—the most obvious medium being the air. The third brings us back to waves, but waves of an extraordinary and quite intangible, not to say unimaginable, kind. They are of the same nature as light waves—which we shall meet in a moment.

"Heat" is the engineer's science. For heat is, as we have said, essentially the intensified movement of the molecules; and that is Energy—energy which produces work. Producing work from heat is what the machines of the world are doing for us: the steam engine, the petrol engine, the hot-air engine, the jet engine. The technician's job is to avoid the disadvantages of that heat in his machine—the burning, the warping, the distortion and expanding of its metal parts—and to get as high a "coefficient of efficiency" as possible.

If Heat is the engineer's science then *Light* one might call the astronomer's and the artist's.

Why the artist's? Because of colour. If Life was fortunate and clever to evolve ears so that it might respond sensitively to sound, it was even more clever and fortunate to evolve eyes to appreciate the world of colour and light. Reflections in water, in atmosphere—mirages, halos, auras, Northern Lights and common sunsets: they all have their scientific explanation and their natural beauty, and to know about the first won't kill one's appreciation of the second. Colour in light, we all know, is the splitting of ordinary white light into its constituents, split naturally by the raindrop and artificially by the glass prism or the "refraction grating" which we shall meet in our Astronomy chapter. But how is the colour of things produced?—that is not so easy to appreciate. Put shortly, it is that their atomic structure is such that they absorb *all* the colours of light *except one*, the colour which is theirs. Shine on them a light which is not white, or, in other words, is itself deficient of some of the colours of the spectrum, and you will get queer but calculable results. Perhaps it is at least clear that the artist will need to *know* a little as well as to be able to see and feel and appreciate.

But the more important thing about light is that it *bends*. It bends when it hits the surface of water; but much more importantly it bends when it passes through a piece of glass that is either concave or convex in shape—in other words, a lens. Comparisons are not always helpful, but one could legitimately call the discovery of the lens more important than the discovery of the steam engine or the spinning jenny or many of the other things we read about in our English History books. It is often said that why the Greeks progressed so little in material science was for lack of the lens. (A deeper reason might be that they didn't want to.) Be that as it may, we now have the camera to see and record for us, the telescope to see very far, and the microscope to see the very small.

And now, finally and unavoidably, we come to light in terms of *waves*.

Light, it has been discovered, pulses outwards in waves just as sound does. But it does not need air to do it in. In fact, it does not seem to need anything at all to do it in. As, however, it is difficult to imagine waves in nothing, we presuppose a medium and call it the Ether.

The next thing to realize is that just as our ears are sensitive only to a certain "band" or section of all the sound waves of different length, so the eye is sensitive only to a certain band of the Ether Waves.

In fact, it is a very small band. We see light. But below the light of deep red (that is to say, of greater wave-length) are the waves of heat; and below them are the waves which we use to carry out wireless messages, whilst above, in ever increasing shortness of length, are the ultra-violet rays, X-rays, the gamma rays from radium, and lastly the inexplicable cosmic rays which beat down on our world from outer space.

Now, this is really an amazing business. All those waves have, obviously, each of them a great significance. So significant are they that we are going, as we have said, to leave them—and the science of Electricity which makes them comprehensible—to a later chapter of this book. This is done partly because the present chapter is long and difficult enough already; but mostly because the third part of the book covers the "Achievements of Man", and the crowning achievement—for good or ill—is the "splitting of the atom" or the release of nuclear energy, which achievement is bound up very intimately with those Ether Waves (or Electro-Magnetic Waves, another name for them) and the activities within the atom which cause them.

And that last is the one thing about these waves that we will try to get into our heads in this chapter.

Just as sound waves are caused by vibration or movement in the thing causing the sound, so all these ether or electro-magnetic waves are caused by vibration or movement, in this case of the molecules or the atoms or electrons making up those molecules. The molecules dance their perpetual energetic dance, moved to a frenzy by heat; free electrons flow in a wire and we call it electric current; the gyrating electrons in the atom change their orbit, or in the last extremity fly off even from the central nuclear fortress of the atom, disintegrating matter in the process. The result is always: *waves*, pulsing outwards. And because the movements and speeds of the molecules and electrons are so much more violent and intense than the mere vibrations of our harp string or our tuning fork, so the speed of light is greater than the speed of sound. It is incredibly greater: to the nearest thousand, 186,000 miles per *second.* That indeed is a limiting speed; Einstein tells us categorically, "it would be foolish to speak of a speed greater than the speed of light; it cannot exist".

But Einstein and Relativity come later too. . . .

BOOKS: As with Chemistry, text-books don't in the least serve the layman's purpose. Indeed his purpose is probably best served, where Physics is concerned, by one of the many books on General Science. These may also cover Astronomy and Biology, etc., but will nearly always cover Chemistry and Physics, and so it is convenient to mention them here. There are so many that the simplest course is to give authors only. These are some that are recognized as experts with a flair for popularizing their subject: J. W. N. Sullivan, E. N. da C. Andrade, Lancelot Hogben, Sir James Jeans, Julian Huxley, J. B. S. Haldane. A book by two of these, Andrade and Huxley, is *Simple Science* (Blackwell).

CHAPTER III

THE WORLD IN SPACE

(Astronomy)

Thy dawning is beautiful in the horizon of the sky,
O living Aton, beginning of life!
When thou risest in the eastern horizon
Thou fillest every land with thy beauty.
Thou art beautiful, great, glittering, high
above every land,
Thy rays encompass the lands, even all that
thou hast made.

All cattle rest upon their pasturage,
The trees and the plants flourish,
The birds flutter in their marshes,
Their wings lifted in adoration to thee.
All the sheep dance upon their feet,
All winged things fly,
They live when thou hast shone upon them.

The barques sail upstream and downstream alike,
Every highway is open: thou dawnest!
The fish in the river leap up before thee,
Thy rays are in the midst of the sea.

THAT is a hymn to the sun written some thirty-three centuries ago. It was written by the Egyptian Pharaoh Akhnaton—visionary, religious reformer, political failure. But whatever else

Akhnaton did or failed to do, he had a very live and deep appreciation of the power and beneficence of the great orb that shone above his lands.

And that of course is why these few lines from his poem begin this chapter. For he realized that it was indeed *the Sun* which gave life to this world of ours. However much nitrogen or oxygen there may be, or anything else, if there is no light there will be no life. The sun may be one of myriads of stars, it may not even be a very important star; but to us it is of supreme importance: a great sphere of unimaginable incandescence and activity, "splitting its atoms" as we should say, and radiating its energy to reach us across a vast tract of space as gracious and beneficent heat and light.

Now let us turn from poems and generalities and list some hard facts and big numbers. We will list them first and try to digest them afterwards.

The Earth is a little under eight thousand miles in diameter.

The moon, a little more than a quarter of the earth's diameter, is roughly a quarter of a *million* miles away. (We leave such a small number as thousands behind already.)

The sun, over a hundred times the earth's diameter and over three hundred thousand times its mass, is approximately ninety-three million miles away.

The sun is a star and its next nearest neighbour-star is about twenty-five billion (25,000,000,000,000) miles away.

Numbers and noughts are growing fantastic; they are beginning to lose their significance for us. We change therefore to a new unit of measurement. The mere terrestrial mile is useless. We measure therefore in *Light Years*, or the distance travelled by light in one year. How many miles is that? At 186,000 miles a second for the speed of light, it is $186{,}000 \times 365 \times 24 \times 60 \times 60$: roughly six billion miles.

Now we can start again.

Our sun is one of some two hundred thousand million stars forming our own particular *galaxy* or "local universe". This local universe is something in the order of a hundred thousand light years across. So far only eight stars have been found within ten light years of our sun. (And light reaches *us* from our sun in about eight minutes.)

There are other "island universes", besides our own, in different stages of evolution—perhaps seventy-five million of them. The nearest is something like a million light years away: the light that we now see from it started travelling a million years ago.

Time-measurement, indeed, is as colossal as space. Here is just one figure in terms of time: our own Earth was formed probably between one-and-a-half and three thousand million years ago. . . .

Now, how are we to digest such figures as these, what mental pepsin can we take?

First let us try, really and solemnly, to appreciate them, not merely dismiss them as unimaginable. Light travels at so great a rate that for all terrestrial purposes it is practically instantaneous. And yet we look at the very nearest star; and, could we but see what is happening, it would be the happening of four years ago. We look at the Milky Way, and we are seeing light that started coming to us at a distance of time perhaps fifty times greater than the span which separates us from William the Conqueror. And then, time itself. How to begin to think of a million years, let alone a thousand million? The other way round perhaps is easier: a thousand thousand times as long ago as that same William the Conqueror; even then this world upon which both he and ourselves have lived had begun to spin. . . .

There is, however, really nothing much we can do about it all—but think, and be impressed, and feel more than a little uncomfortable. There it is, the very opposite of the molecule and the atom, where we have, so to say, a sort of colossal littleness. Vast expanses of time we must contemplate, vast expanses of space, with suns dotted about it as sparsely as the electrons in an atom.

One question is inescapable as we think of all this. Our Earth is one of several planets to our sun, and the other stars are suns too; do these other suns, then, possess satellite planets with life on them as does our Earth? The answer is that, whilst rather obviously nobody can know for certain, the chances of its happening to any particular star are small—though by no means non-existent.

Now to fill in some of the bare facts and big figures with a little more explanation.

There are, we appreciate, three stages of vastness. First there is our own planetary system, where the Earth and eight other satellites (some with satellites or "moons" of their own) revolve round the sun. Then there is our own island universe. To call it a universe is actually a contradiction in terms, because universe means all and everything. But it is only comparatively recently that we have realized that there is anything else. We call it sometimes the galactic universe, using a poetic word, "the galaxy of heaven", for a scientific purpose. It is a system of stars, a bunch of them numbering as we have already said 200 thousand millions or so; and it is shaped like a thick magnifying lens, or, less scientifically, a thin bun. That is why you see the Milky Way, which as most of us know is simply a mass of stars, so many and so distant that without a telescope we can distinguish only a thin white mist. Our sun and Earth are somewhere in the middle of that lens or bun; and when we look at the Milky Way we are looking roughly along a radius to its edge.

Finally the third order of greatness comprises those other universes like our own—we in fact start all over again. The nearest is in the constellation Andromeda, and can be seen as a small oval misty patch through quite a small telescope. Another is in the sword of Orion. Only the powerful telescope and the powerful intellect has told us what they must be: "spiral nebulae", whirling slowly—or apparently slowly—with long curved arms that extend in hundreds of thousands of light-years across empty space. Perhaps to some planet or some sun in one of those nebulae, our galactic universe, Milky Way and all, looks too like a misty catharine wheel through a powerful lens.

There is more than one theory as to how our sun gave birth to planets. One idea is that by a colossal chance another star passed by and drew out by attraction a long cigar-shaped streamer of gaseous matter, which later solidified into separate planets. But there is a later idea which is gaining in popularity—after all, it is a matter of guesswork, intelligent and informed guesswork.

This later idea is based on two known facts. One is that many stars go about in pairs, "binary" stars they are called—often a big one and a little one. The second fact is that stars, at some time in their long history, *burst*. Perhaps, then, long ago in the unimaginable past, our sun lost his small brother by its bursting—and begot a number of children instead. That, in picturesque rather than scientific language, is the new guess. Incidentally, if it is true, the chances of other stars having planets is considerably increased.

In miles the sun's planets are distant enough from their parent, but in light-time they are comparatively near. Here is a table—and remember that the nearest star is about four light-*years* away.

PLANET	APPROXIMATE LIGHT-TIME FROM THE SUN
Mercury	3 minutes
Venus	6 ,,
Earth	8½ ,,
Mars	13 ,,
Jupiter	43 ,,
Saturn	1 hour 20 ,,
Uranus	2 hours 40 ,,
Neptune	4 hours 10 ,,
Pluto	5½ hours (perhaps)

Now what about life on the other planets? That is another inevitable question. The answer, shortly, is: very unlikely. Most of them, apart from having no oxygen (or, like Mercury and for that matter our own satellite moon, no atmosphere at all), are either too hot or too cold, too near the sun or too far away. Only Venus and Mars hold out possibilities. Venus is perhaps what our world was like millions of years ago, with little oxygen, much heat and water vapour and perhaps the beginnings of vegetation. Mars is what our world may be like millions of years hence, if and when the sun cools: dry and arid and with night temperatures at the equator of 130° Fahrenheit *below* zero.

How, we can very usefully ask ourselves, was all this amazing and rather unbelievable knowledge amassed? The history of it is largely the history of one particular instrument helping the brain of Man—the telescope.

Galileo did not invent the telescope, but he heard of it in 1609 and was the first to use it to great purpose. He discovered that there were mountains on the moon, spots on the sun, rings round Saturn and four moons round Jupiter. To this last the wise men of his time, still steeped in the unscientific, geocentric outlook of the Dark Ages, replied brightly: "These satellites of Jupiter are invisible to the naked eye, and therefore can exercise no influence on the Earth, and therefore would be useless, and therefore do not exist." Galileo also saw through his telescope that Venus had "phases", that is to say, that it first showed a little of itself and then more and more to fullness, just as we see so clearly in our moon. And that was of great importance, because it proved—at least to Galileo's own satisfaction—what his predecessor of a hundred years and more, Copernicus, had ascertained (*without* the telescope), to wit that the Earth and planets went round the sun and not the sun round the Earth. For those phases are of course caused by a body "catching" or reflecting the light of sun and would only be so seen by us if both it and we were in fact sun-satellitic. Copernicus had never been able to prove that. But now people were faced with an incontrovertible truth—and a truth which they didn't like because it seemed to cast a slight upon the importance of the Earth. (In just the same way people did not like Darwin because his theory of Evolution seemed to slight mankind.) The story of how Galileo was made to recant, but nevertheless whispered under his breath, "e pur si muove!" ("nevertheless it does move"—the earth round the sun presumably), is well known if not strictly verifiable.

Herschel (who was the son of a German bandsman and came to England with the Hanoverians) is the next great name in astronomy. He mapped the Heavens with extraordinary patience, and—besides discovering another planet—was the first really to appreciate that the so-called fixed stars (the non-planets) were not only moving but were each a separate sun like our own.

The rest of the story is too long and diverse to tell here. Measuring the Universe came next, and then the task of discovering what it was made of.

That last brings us back to the spectroscope, which we merely mentioned in the preceding chapter. That the Earth was made up of ninety-odd elements was known; but were the sun and the stars and the spiral nebulae also made up of these elements and no more? The answer was, yes! The means of obtaining the answer was the spectroscope.

There was at the turn of the eighteenth century a German glass-worker and lens-maker who was not only good at his job but of an enquiring mind. He noticed that the spectrum which his very well-made prisms gave him had more in it than the mere "rainbow"; it had thin black lines showing at odd intervals as well. Then came Herr Bunsen to discover that if you took the spectrum of a *vapour* of an element, you got these lines coloured with dark spaces in between, and that the lines *varied with the element vaporized.* (He invented his burner for this purpose and not merely to amuse schoolboys.) He and others then turned their attention to the elements that were all the time being vaporized in the sun and stars—and found that they had invented the perfect instrument for finding out what the universe was made of. Through the spectroscope one is, as it were, watching the behaviour of the electrons: their number within the atom determines the particular element, and their vibrations cause the waves which we call light. The spectrum has even helped us to find elements on our own doorstep by first noticing them in the Heavens—helium, for instance, was found first, as its name implies, in the sun.

And now finally, to close the chapter, let us be a little more homely and familiar. Let us relate the stars to ourselves.

To ordinary, poetic man, the stars, very rightly, are not distant suns in space, and spiral nebulae, and island universes; they are "the canopy of Heaven", and the constellations, "The Ram, the Bull, the Heavenly Twins", Orion and his sword belt magnificently straddling the sky.

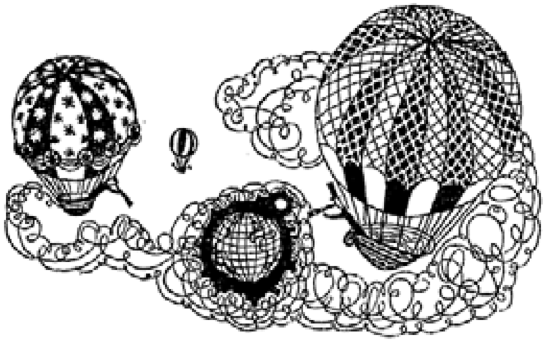
Don't scorn all that. Not only is it romantic and beautiful. There is also a great deal of history behind it—the history of mankind learning to guide his cycle of life by the seasons as foretold by the rising and falling of those same constellations. Only the city-dweller, with his city lights, does not see the stars. But if you were a sailor, with only the dark sea and the dark sky around you, if you were a shepherd looking for a guiding light, if you were a primitive husbandman with no clock and no calendar to guide you—then would you most certainly have noticed the sun and the moon and the stars and the planets and have learned your lessons from them.

But in surrendering to that romance, do not, for pity's sake, go too far! A great deal of superstition was, rather naturally, mixed with the knowledge of those early men. Nowadays one may admire Orion on a frosty winter's night; but one does not believe that he is a reality or an influence upon our lives. In other words, and more plainly: Astrology is not a science.

Fix your eyes rather, then, on the Pole Star, and combine romanticism with realism. Round that central star, to which the axis of our world happens by chance to point, the rest of the stars gyrate. In reality it is our world that is spinning. Envisage that world then, spinning in the vastness of space, made of the same stuff as all the rest of the universe and obeying the laws of that universe; a child with other children of the light-giving sun, and a favoured child at that; a place where, by some great chance, life is possible and where life has indeed proliferated and flourished and evolved. That is what you must envisage; and that is *the Home of Man*.

BOOKS: Generally: *The Stars in Their Courses*, by Sir James Jeans (Cambridge University Press.) For "star-gazing": *The Night Sky*, by J. G. Porter (Winchester Study Library). *The Marvels and Mysteries of Science* (Odhams Press), lavishly illustrated, has a good first Section called "The Wonders of the Heavens". Another elementary book is *Wonders of the Sky*, by Mary Proctor (Warne). For deeper reading, besides Sir James Jeans go to Eddington and F. Hoyle, whose Wireless talks have been published by Blackwell under the title of *The Nature of the Universe*.

NOTE: Chapter XXI seeks to explain something about electromagnetic waves and makes mention of "Radar". This—essentially the observing of the backwash or "echo" of these waves after they have hit an object—be it aeroplane or heavenly body—is becoming the new tool of astronomy. Unsuspected meteor showers are being discovered, perhaps unsuspected stars.



CHAPTER IV

THE WORLD ITSELF

(Geology and Geography)

IN the way of strict derivation, Geology and Geography mean pretty much the same thing, *Geo* being the Greek for the Earth, *logos* for a word or a discourse, and *grapho* meaning "I write." So, in theory, one means talking about the Earth and the other means writing about it.

But this sort of scientific term has a habit of acquiring a rather changed or derived meaning. True that both are sciences that tell us about the world we inhabit. But geology has come to mean : all about the fundamental structure of the Earth, the rocks of which it is made, the story of those rocks, and their influence on the world's present scenery. Geography is not concerned with rocks. It is concerned with weather and climate, the physical features of the scenery that those rocks have built up and made possible, river and ocean, mountain and valley, Nature-made countryside and man-made town.

Geography is really a subject very hard to define. It is not one subject but many, or, rather, a part of many; as we said in our introductory chapter, it "connects". That is perhaps why the unhappy schoolmaster, set to teach Geography in a watertight compartment, finds his task difficult, and why many of us leave school with a feeling that Geography was and always will be a dull subject. Geology, on the other hand, is taught little or not at all at school, so that quite unnecessarily it may seem a mystery to us for all our lives afterwards. Indeed, one might say that the difference between geography and geology is that the first is something we are taught and don't want to learn while the second is something we do want to learn but are not taught.

The best thing we can do is to forget that it is any science or school subject or subjects that we are trying to tackle. Rather it is that we are trying to get a picture of the World We Live In. A great but unorthodox teacher has called his book on geography simply the *Home of Mankind*, That is the way we will look at the whole matter here.

The Earth had a very long history indeed before it became fit to be the home of mankind. It is a story of cataclysmic happenings, spaced out very widely; the history is longer even in expanse of time than in category of events. To begin to understand astronomy we had to alter our whole conception of time, we had to struggle to grasp the significance of an immensely longer time-scale than we should ever have had to contemplate in learning human history. That new conception of time has to be carried over to our contemplation of Geology.

We take over from Astronomy, then, and contemplate our Earth born as a ball of fiery vapour somewhere between one-and-a-half and three thousand million years ago.

Gradually it cooled and solidified. A "separating-out" process ensued. The heaviest elements sank to the centre, forming a core of iron; light minerals floated to the surface, to form a crust of granite perhaps twenty miles thick (called the *Sial*); between the two the moderately heavy minerals formed a thick layer of rock (called the *Sima*) resembling the volanic lava, basalt. As for the lightest elements, they remained, quite simply, our atmosphere, though charged with a much larger proportion of water-vapour than we have now, so that a great pall of cloud must have covered the Earth.

One day it rained: the greatest day in the history of the world perhaps. We can imagine the first rain sizzling on the hot rocks of a lifeless world. Soon—very soon no doubt as geological time goes—the rain ceased to sizzle back to steam, but stayed on the surface to form the sea: "The waters covered the Earth."

Then—somewhere—curious and important things happened to those inner and outer crusts called the Sima and Sial. Some force, perhaps the gravitational pull of the sun itself (which was then much nearer the Earth than it is now), ripped off nearly three-quarters of the Sial and quite a lot of the Sima too. The torn-off mass whirled away into space and condensed into a ball—the moon. The slab of Sial left behind split up into some half-dozen bits, which drifted away from one another, floating on the Sima as icebergs float on the sea, partly immersed, partly projecting. These formed our continents. On the bare areas of

Sima there formed the oceans: "The waters were gathered together into one place."

Then another important day came: the day when the sun for the first time penetrated the cloud-pall, and the first patch of sunlight and the first shadow appeared on the face of a still lifeless earth. The stage was at least set, and waiting, for life.

But we are not telling the story of Evolution; that comes later. We are thinking here of rocks and pressures—pressures particularly.

For it would be wrong to think of the inside of the Earth as just glowing and molten matter, a sort of extra large furnace. Nobody can say for certain what is its state—except that it is very dense or "heavy" and, as we have said, subject to very great pressure. We come here to some new names. The core of our Earth we sometimes call the barysphere (*baros* means heavy); above this come those layers of rock, the Sima and Sial, called the lithosphere (*lithos* a stone or rock); above that the hydrosphere (*hudor*, water); and above all the atmosphere.

But nothing is stable: that is the thing to remember. There is pressure, and shift, and change, over tens and hundreds of millions of years. That idea of the continents "floating" is perhaps novel. But it is true. One must remember, however, what differences in liquidity there can be: treacle is liquid, even pitch we can call liquid, the Sima will shift and let the Sial move through it—given enough pressure, given enough time. . . .

Is it then a true fable of an ancient continent disappeared, of an Atlantis gone down in disaster in some forgotten cataclysm? It would be much truer to say that for all we know there may have been many such continents and cataclysms—though not necessarily so or perhaps even probably so—both since and before the appearance of mankind. Put it this way: those pressures and those movements of the "floating" Sial have through all time produced, and are still producing, changes on the face of the Earth, shifting a continent here, squeezing up a mountain range there, dropping or raising a land surface elsewhere, so that where once was land is now the sea and where once was sea is now dry land. You know those speeded-up ciné-films of plant growth. If perhaps we could have taken photographs of a landscape once every thousand years and then could show it as a moving picture on the screen we should see a continual drama of change—and it might still take as long as *Gone With The Wind* to show.

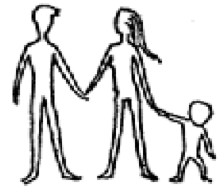
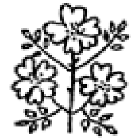
But there are other perhaps less obvious and spectacular pressures and forces at work besides those of the bary- and the litho-sphere. There are those of the hydro- and atmo-spheres. In other words there is weather and wind and water. There is in fact a wearing down as well as a thrusting up, a continual cycle and a continual balance between one and the other. As soon as a mountain range is thrust up, the rain and the wind (or rather the sand and dust that the latter carries) begin to smooth it down, frost and heat crack and splinter its rocks, and the rivers carry the lumps and particles that have been dislodged down to the sea. (Nor must we forget the "river of ice" or the glacier. The power of the glacier, as one would perhaps expect, is tremendous—it has in our own country carried lumps of granite from the Lake District down as far as Wolverhampton.) What we get, then, is in one place erosion or denudation (laying bare), and in another the deposit of sediment (or something "sitting down" when it gets to the bottom).

To geologists in fact there are originally only two kinds of rock, *igneous* and *sedimentary*. Igneous rocks (from *ignis*, Latin for fire) are upthrusts of molten material from the hot interior into cracks and fissures in the crust, or out on to the surface through volcanoes. They are the granites and basalts, lava flows and ashes.

Sedimentary rocks are found either on land or under water, when the materials carried down by river or glacier reach an area of calm and can settle—to form clay and gravel and sandstone and pebbly rock called conglomerate. (Remember that to a geologist all the Earth's surface except soil is "rock".) Limestone and chalk (a form of limestone) are sedimentary rocks too, but of a particular and significant kind. Limestone is composed of calcium carbonate, which is what seashells are made of. In fact it *is* seashells, large and small and microscopic, which have sunk down to the bottom over millions of years. Where there is limestone, there must once have been sea.

There are two fundamental facts about the sedimentary rocks which are supremely important to the science of Geology. One is that these rocks have formed in layers or *strata*. The other is that there are found embedded in them the fossil remains either of the hard parts or (very rarely) the moulds and imprints of the softer parts of the animals and plants that lived in the area at the time those strata were formed.

Two things follow from that. First is the fact that although these strata get shifted, up-ended, even turned upside down or folded into ribbon-like zig-zags by the pressures and upheavals that we have talked about, it is still possible to compare the fossils in the strata in different parts of the world and so to see a little of what has happened in the past. We know what kinds of animals lived in different geological ages and we can distinguish between those that lived on land, in fresh-water lakes or ponds, and in the sea. Second is the fact that sometimes we know roughly how long it took to form the various strata and so can make a good guess as to how long ago in time lived the embedded fossils. This is the true "Story of the Rocks", which has given us such an insight into the long-past history of life on this planet. All that

ERA	PERIOD AND ORIGIN OF NAME	APPROXIMATE DURATION IN MILLIONS OF YEARS	TYPE OF LIFE BEGUN
QUATERNARY	HOLOCENE (or wholly new) PLEISTOCENE (or most new)	$\frac{1}{2}$	Man 
TERTIARY or CAINOZOIC (new life)	PLIOCENE (or more new)	10	Modern Birds 
	MIOCENE (or less new)	10	
	OLIGOCENE (or slightly new)	10	
	EOCENE (or dawn of new)	20	
SECONDARY or MESOZOIC (middle life)	CRETACEOUS (chalky)	55	Flowering Plants 
	JURASSIC (first found in Jura Mountains)	33	Birds 
	RHAETIC (found in Rhaetic Mountains)	10	
	TRIASSIC (three-fold division typical in Germany)	30	Mammals 
PRIMARY or PALAEOZOIC (ancient life)	PERMIAN (found in Perm, Russia)	30	Reptiles 
	CARBONIFEROUS (or coal bearing)	60	Amphibia 

PRIMARY or PALAEOZOIC (ancient life)	DEVONIAN (found in Devonshire)	40	Trees, Seed Plants, Land Plants, Insects
	SILURIAN (ancient British tribe on Welsh border where found)	30	Fish
	ORDOVICIAN (another Welsh border tribe)	50	Vertebrates
	CAMBRIAN (found in "Cambria" or Wales)	100	Trilobites
EOZOIC (Dawn of life) or PRECAMBRIAN		?	Primitive life—working up from unicellular types to jelly fish, lime depositing plant-animals, and others

however must wait until we come to Biology and the story of Evolution.

Before we leave the rocks we must say something on the long eras of geological time and the names which the geologists have given those periods. These names are not easy to remember, particularly the subdivisions, since they have been named after no set plan, sometimes using Greek words, sometimes the area where first found, and so on, even becoming so picturesque (but confusing) as to drag in the names of Ancient British tribes who once lived in the area concerned. The accompanying diagram may help.

But now we must shift to what is classed as Geography, away from the skeleton structure of the earth to what Nature has built upon that structure. To call the rocks the Earth's skeleton, and the countryside or scenery the Earth's flesh, is rather obviously not a perfect simile. Nevertheless it is a good and a useful one.

That rocky moorland or that rolling down: the one will be hard, resistant, "igneous" granite, the other soft moulded chalk through which the rain and water filter easily. Why is this valley V-shaped in cross-section and the other like a U? One, the geologist will tell you, has been scooped out by a river, the other by a glacier. Why will only heather and gorse grow in one place, only sedge in another, pine forests here, short grass only there? The answer is: because of the types of geological "rocks" below, rocks that hold the water or drain the water, bare igneous rocks, sedimentary clays, or rocks covered by a topping of rich soil, and so on and so forth.

Think of rivers. Geological structures affect the course and behaviour of rivers, and rivers by the silt and sediment that they carry down form new geological structures. Rivers are themselves tremendous alterers of the landscape—and, thinking in terms of geological time, very rapid ones. We have all seen the silted-up harbour or river mouth: some of us may have seen the amazing Colorada Canyon, where the river has cut itself further and further down through sandstone and limestone and clay to the ancient granite below. Rivers meander and by swaying from side to side in their course increase their meandering; rivers, too, change their course. What is more surprising, rivers may have estuaries that are not in the least silted and muddy but always water-filled. The River Yealm and other Devonshire rivers are such. The geologists call these *drowned* rivers. The land has sunk or the sea has risen in some distant shift or change in the floating lithosphere; and what was once a wide muddy estuary is now a long arm of the sea.

Rivers, too, have had a tremendous influence upon the life of Man. The first civilizations grew up round the fertility of the great river valleys, the Nile, the Euphrates, the Ganges. Sometimes the river was, rather, a challenge to Man : you must live on the hard dry uplands until you have learnt to drain your marshes. Men did so learn. The river carried his first merchandise. It created his first port. It also, do not forget, very often got badly in his way.

It is not easy for the modern town-dweller to realize how much the river has at times got in the way. After all, you can always cross it by the bridge. But who built the bridge? And is a bridge always an easy thing to build? Read the story of any war, any campaign, ancient or modern, and you will realize how important the river can become when you leave your comfortable and civilized town. In earlier times before the bridge it was the ford that mattered. Think of the number of towns and villages whose name ends in "ford". Ask yourself just why a town grew up where it did, and very often you will find that a river has much to do with it.

Other things dictate the site of a town: passes through the mountains for instance. And to think of these things *is to begin to think geographically*, to begin to see the significance of geography. Geographical features can and do affect the whole way of life of mankind. The mountains of Greece are a classic example: Greece by the very formation of its land lent itself to the idea of the small, separate city-state.

But it is not only the lie of the land that influences mankind; there is the state of the climate above.

Climate is, quite simply: *generalized weather*. Add up the day-to-day weather of a place and take its average, and you get its climate. The climate of a place depends first and foremost on the position of that place on the Earth's surface. It depends on air currents (winds) and sea currents. It depends on the variability, the intensity, the duration of its seasons. And those seasons, and the very fact that there are seasons and not one long uniformity, depend entirely on the way in which the Earth revolves round the sun in space. That is why geography proper begins with an appreciation of just how the Earth does revolve.

To visualize that is none too easy. The trouble is that we need to think in three dimensions, whereas all our maps, all our pictures, are of necessity in two. That is why such a book as Van Loon's *The Home of Mankind* is valuable, because by his clever sketches he does make you visualize a *planet*, something spherical floating in space.

Take any opportunity that offers to study a geographer's globe, the bigger the better. Imagine yourself approaching it, extra-territorially, in some space-ship of the future. There it is first, shining in the sun's reflected light, very much as we see the moon, with vague markings, that we make perhaps into a picture—*The Man in the Earth*. Then cloud masses distinguish themselves from the real Earth below, colour comes into the picture and we distinguish land from sea. The shapes of the continents make themselves apparent. There is a great deal of sea, a surprising amount—indeed it would be possible by approaching the great expanse of the South Pacific to think for a while that there was no dry land on the Earth at all.

That is our Earth spinning in space. To understand the *Seasons* we must bring the sun into the picture. If you have a globe, bring in a bicycle lamp with a good parallel beam, turn out the room light—and experiment.

The whole business of course turns on the fact that the Earth, as it circles the sun once a year, itself spins at a set angle, *at a slant*, to its motion round the sun. If it were spinning straight or "upright"—that is to say if a line through its poles were at right angles to a line from the Earth to the sun—these things would be much simpler, and *very* much duller.

Remember that if sunlight falls at right angles on to a surface it will heat that surface much more than if it falls at an oblique angle, and the more oblique the angle the less the heating, because the parallel rays have to cover a larger surface. Remember too that if the sun is above the horizon for a longer time—that is to say if the day is longer—then obviously it will have longer in which to exert its heating effect.

Now if the Earth were spinning straight there would be no Seasons but there would of course still be hotter and colder parts on the Earth: permanently and evenly hot at the equator in fact, with the sun directly overhead every day, and permanently and evenly very cold at the poles, with the sun always just on the horizon and never rising above it.

But give the world that tilt and see what a difference it makes! Now for half the year the Northern hemisphere is tilted towards the sun, and for half the year the Southern. And whichever is tilted gets longer days than nights and a sun climbing higher in the Heavens. There is now no question of a uniformly hot equator and frozen poles. Of course there is a tendency towards greater heat as you approach the equator; but besides that there is this perpetual cycle of increasing and decreasing temperatures as each place on the Earth throughout the year finds itself first more directly and then less directly facing the sun's beams: *Spring, Summer, Autumn, Winter.*

There is however a good deal more in climate than the twin facts of seasons and greater all-round heat near the equator. Again we may imagine a simplified Earth, in order to bring out by contrast the complications of the real facts. Imagine a world either all sea or all land of a uniform height. Then you would have utterly regular gradations from hot climates to cool, and spring and summer would arrive at the same time and with the same degree of warmth in all places of the same latitude.

But we have no such dull simplicity. We have seas and islands, and continents of all shapes, and mountains and valleys. We have also an *atmosphere.*

Certainly do not forget that atmosphere, or the fact, which we learnt in Physics, that air has density or weight.

Air therefore exerts pressure—and a pressure which varies, chronically and very significantly. It varies, we must realize, with two things: the heat of the air, and the amount of water that has evaporated into it. And *those* depend very largely on what happens to be below: frozen land, to take two extremes, or warm wet sea.

Add one more fact: air pressures and temperatures govern wind and rain. Winds flow towards the areas of "depression" or low pressure—in other words they fill the gap. Rain falls when air cools and can no longer hold the moisture that up to that moment it has held.

There in outline you get the picture of the world's climate. And—which is the real point to be made here—it is a complicated picture because this tilted and patchwork world of ours not only has its seasons but its great variety of surface.

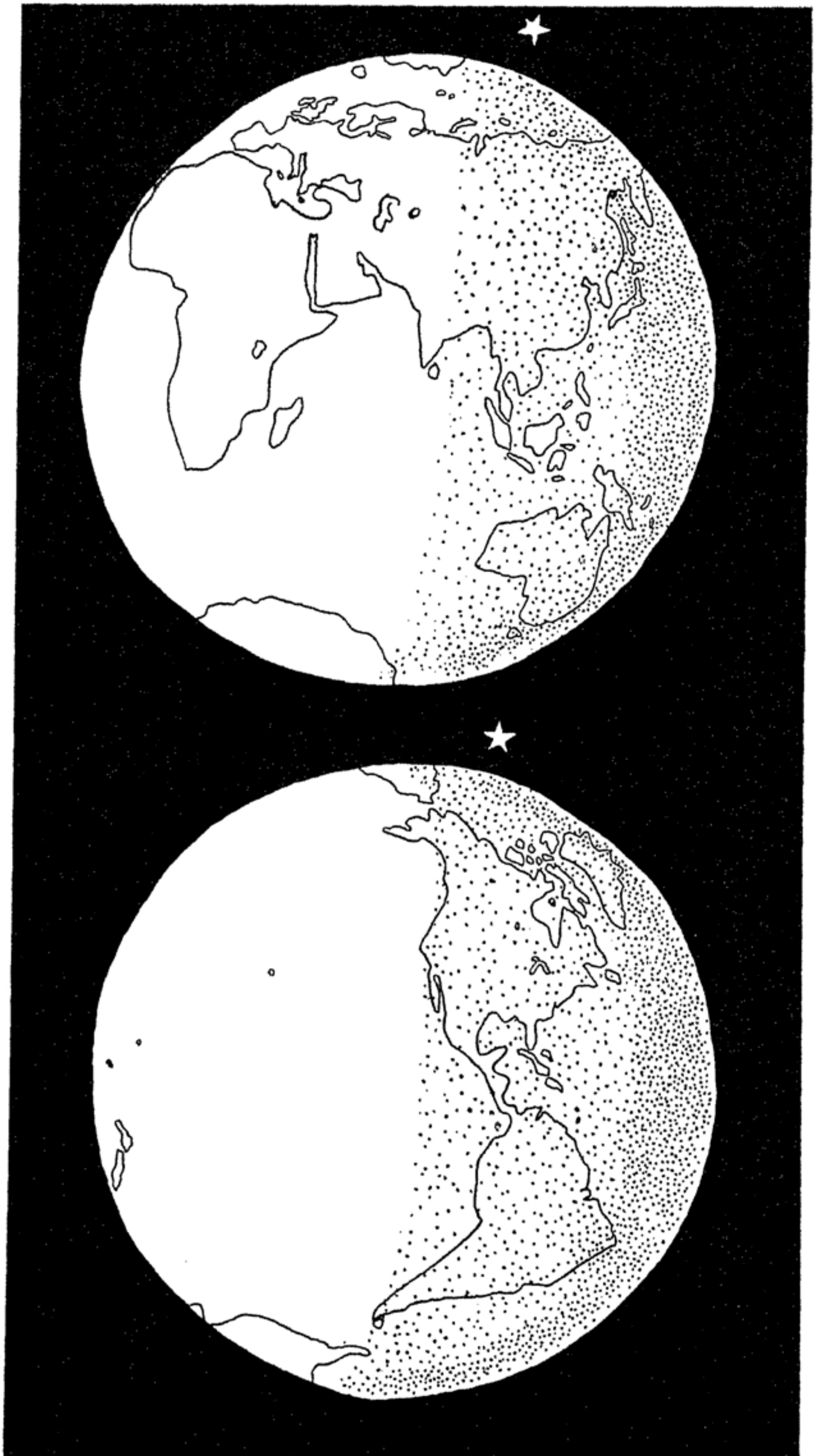
There is therefore tremendous variety of climate; there is therefore tremendous variety in what grows upon the earth; and there is therefore tremendous variety in mankind.

That is the real essence of geography: the influence of the earth's form and climate upon the lives of men. . . .

Not only the lives of men but the types of men. You will be a different person if you live amidst gloomy forest or if you live in wide airy plains, in an igloo or a house of paper and matting; a tender of horses is different from a keeper of camels; a consumer of caviare differs from an ice-cream addict, and an imbiber of rye whisky from him who quaffs the juice of the grape, "the true, the blushful Hippocrene". . . .

And if you point out that you yourself tend neither horses nor camels and can get all those other things out of tins or bottles if you want to (or can afford), then the argument is in no way vitiated. It is only shifted. For Man, as we have said before, is the one animal that begins to affect his environment while yet it is affecting him. Geography influences men, but men begin to influence Geography.

For the rest, Geography, one might say, merely gets down to detail. Country by country one will study a particular environment and what its human inhabitants—men becoming through the long course of history increasingly industrial and commercial animals—have made of that environment. So Physical and Commercial Geography respectively.



The World In Outline

But in this book we are concerned with broad outlines, not details: they will come in your further reading.

But there must be a few last paragraphs about *maps*.

Any self-respecting person must surely be able to do two things: carry in his mind's eye at least a passable picture of the map of the world (as shown here)—and beware of the distortions of that crudely flattened-out affair, Mercator's Projection—and, secondly, be able to read a large-scale map when he needs to do so in his own travelling, whether it be by foot or bicycle or motor or train.

Surely, too, it will help to believe that maps are romantic—which they are. It may help to think of them as pictures—bird's-eye views taken from varying heights, the greater the height the smaller the scale.

Remember that a good modern atlas will tell an amazing amount, more than can be got from the ordinary "physical" and "political" maps: climate, soil, rainfall and plant growth; geological structure below the surface, cloudiness above it, the types of human population upon it, and so on. There is also the diagram type of map, which by an ingenious use of shading and arrows and so forth can show *action*: population changes, trade changes, political changes. That is half geography, half history. The great expert at it is J. L. Horrabin, who did the diagrams for H. G. Wells's *Outline of History*. Some people learn more easily by the aid of that sort of thing, some less.

And as a footnote, let there be no confusion about those lines on the maps called isotherms and isobars. They are simply lines joining places with the same temperature or the same *bar*ometric pressure, just as contours join places of the same height. You can indeed have other such names if you like—for instance isohyets for equal wetness or rainfall—for the very simple reason that *isos* means in Greek "equal".

BOOKS, etc.: Van Loon's *The Home of Mankind*, already mentioned, is probably the best book to ram home the idea that geography is not a dull subject and to startle you out of your dislike if you have any. There is also *Modern Geography*, by Marion L. Newbegin, in the Home University Library Series.

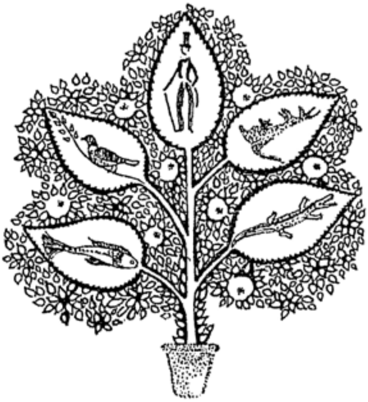
An Introduction to Geology, by A. E. Trueman (Thomas Murby & Co.), will make a good start on that subject. But if you want to follow geology and its influence on geography really far you will get *Principles of Physical Geology*, by Arthur Holmes (Nelson). Even the illustrations in that will impress you with what an utterly amazing thing is this mere crust of our world. *Britain's Structure and Scenery* in the *New Naturalist* series, by L. Dudley Stamp, will tell you about the country you live in, though it is not a text-book for beginners. A suggested atlas of medium price is *The University Atlas*, by Goodall & Darby (Philips).

But, as any geographer will tell you, half the battle is not to read but to *see*. And this is a point likely to go unappreciated: that we in the British Isles are supremely lucky in having such geological and geographical variety in such small compass. Live on the Canadian prairie or mid-European steppes, and go twenty miles and you are still in prairie or steppe. You will find it difficult in this country to go twenty miles anywhere and not find a change, and probably a striking change at that.

Remember, too, that this country shares with Denmark the reputation of having the best maps in the world. Buy, then, for a few shillings, Bartholemew's *Road Atlas of Great Britain*; buy a one-inch map of your own district and even of every district to which you go for a holiday. Then go forth and observe. Ask yourself: why is there a town here, a mill or factory there, why so few people in this area, why are the hills this shape, why has this village this fascinating name, why is that village built of stone and not brick, why walls instead of hedges between the fields, why these wild flowers here and not those? That is the geographer's advice—and if you don't know the answers he will tell you, somewhere in his books. And remember one thing: geology and strata are best observed in natural cliffs or man-made quarries and railway cuttings.

If you are really interested in the geology of this country there are seventeen *Handbooks of the Regional Geology of Great Britain* at two-and-six a district and these are far and away the best value in geological literature today. You can get them from H.M. Stationery Office.

Finally, tales of travel, exploration and discovery should not be left out of the book recommendations of this chapter. They are not geography. But very many people have learnt more geography from them than they will ever learn in any other way.



CHAPTER V

THE LIFE OF THE WORLD

(Biology; Evolution)

"WE are all," we say glibly in our more sententious moments, "children of Nature." And how little—poor artificial, town-bred people that we are—do we mean that or know what we mean by it. But it is an important truth: we *are* children of Nature; we are—no more, no less—a part of Life.

Life is all around us. This world is not only "the Home of Mankind" but also the home of a host of other living forms—be they animal, plant or microbe—in infinite variety but yet in intimate relationship. The rest of life is in fact an important part of Man's environment: that is why this chapter comes into Part I of the book.

It is a long chapter because this is an important outlook to gain, this realization that all life is one and that we are part of it. We shall try to cover a good deal of ground—though do not be afraid lest we shall have to master a mass of technical words of unexplained Greek origin, as the text-books would try to make us. Biology responds graciously, one may say, to a wide treatment. Neither be afraid of acquiring "the biological outlook", as being something over-scientific, over-modern and perhaps vaguely irreligious. It is nothing of the kind. Call it if you prefer the Life Outlook, the Humanitarian Outlook.

Now, for a minimum understanding of Biology one must appreciate in particular three things:

The Story of Life (or Evolution).
The Variety of Life.
The Interdependence of Life.

First, then, the story. If the day on which it first rained and the day on which the sun first shone are red-letter days in that incredibly distant early calendar of the world, then a gold-letter day is surely that which marks the first appearance of life. The wheels of Evolution on that day begin very slowly to turn.

Evolution begins in geology, with the "Story of the Rocks" and of those prehistoric fossils embedded in the rocks. Or rather, it begins earlier still, since the first forms of life were undoubtedly skeletonless and so have left no trace.

But before sketching this story, there must be two short warnings. The first is that for brevity it must all be over-simplified and *personified*. To say that "Life then climbed into trees and developed cleverer hands and clearer sight" is to portmanteau into a sentence the habits of, say, a million million animals over a million years. Nor was that the only thing that was happening at that time. But it was the most significant thing; and to get the necessary bird's-eye view it is not unfair to talk in this grandly generalized way.

The second point is not unconnected. To personify life in the story in this way is probably to give a much greater idea of *purpose* in evolution than may exist. We say "may" because nobody has the right to be dogmatic upon just how much purpose there is in life: on that is for you to form your own opinions. The *fact* of evolution is now considered indisputable. The reason for evolution, the significance of evolution, those are still matters of opinion and dispute.

If you believe that there is some sort of urge, some "Life Force", giving Evolution a purpose and a meaning, and that species change not by blind chance but because fundamentally they *want* to, then you will be a follower of the early scientist Lamarck (*d.* 1829), of the philosopher Bergson, and you will revel in such a book as George Bernard Shaw's play and preface, *Back to Methuselah*. If you dislike inspired guesses, thinking they should be ruled out because they are guesses rather than admitted because they may be inspired, then you will be an orthodox scientist and Shaw will annoy you. Now we will get on with the story.

Life can *grow* and can *perpetuate itself*; those are the great differences between it and inanimate Nature. The first forms of life must almost certainly have been unicellular specks of living matter—floating unresistingly in the great oceans of the early world or perhaps cradled warmly in drying mud.

Why do we say unicellular or one-celled? Because the single cell is the basis of life, rather as the atom is the basis of matter; our own bodies house millions of such cells, specialized as to their functions but still having usually the basic property of all cells: the power to absorb food and so to continue alive, and the power to proliferate or "have children" by the very simple and elementary method of splitting into two.

Now Life, in the form of specks of jelly rocked in the cradle of the deep, has obviously little control over its environment. The next step is to congregate together—or to stay together after each "proliferation" or split into two. To begin with, the collection will be no more than a colony, with no individuality, no co-ordination, no central nerve or direction. But that will come: in the seaweed for instance, which grows as one plant, and in the jellyfish which not only grows but begins, by pulsations of its body, to be able to swim and direct its own motion. Through the millions of years of the geologist's Eozoic Era that sort of life must have been slowly developing.

But life will never get very far without a skeleton, or bony part. That, if it is outside, will form a protection; if it is inside, will form a framework on which to build a much more complex structure, rather as a modern ferro-concrete building has a framework of iron or steel. The outside "skeleton" was the simpler and first idea. There now comes upon the scene the first life that has left its trace in the rocks. Trilobites were one of the first forms, sea-animals rather like giant wood-lice; and then jointed sea scorpions and a clumsy thing called a king crab, which we should perhaps have thought more like a soldier's steel helmet than the common crab of today.

Fish come next, but again queer, clumsy, heavily armoured fish, with gristle rather than bone as a skeleton and lacking as yet that very necessary instrument for proper eating, a hinged jaw. Fish proper will evolve from these.

But notice that so far we talk only of the sea. Life is *tied to water*, to that moisture which is still necessary for the functioning of our own bodies but which we have learnt to encase in a drought-resisting skin. The world awaits the invasion of the dry land.

What has Life to do before it can emancipate itself from the sea? Most important of all, it has to learn to use air for respiration. It has also to produce that hard encasing skin to prevent drying up, and it has to find the added support necessary when the water is not there and there is something more to be done than swim and wallow and flounder and wave about in the currents.

Now already there is a division between plant life (the seaweeds) and animal life. Plant life invades the land by first encasing its self-propagating part (or seed) in a drought-resisting shell and then by developing the stiff gravity-resisting stem or trunk. Animal life not only develops the drought-resisting skin but also grows legs and learns to breathe pure air instead of air dissolved in water.

The first skin and the first legs were not very good. It was the *amphibian's* skin, a skin that still needed to be kept moist by occasional immersion in water if its owner was not to dry up like a dehydrated vegetable. Legs were short and clumsy and probably could not support their owner for long without the added support of shallow water. Life in fact is finding it difficult to shake off the ties of water; in its upward adventure—and remember we are only following the "main line" that leads to Man—it actually leaves behind a whole type of life, the sea-shore life, of sandworm and shellfish and sea anemone, which as it were remains content to stay at a half-way stage depending on the returning tide to lave it and refresh it twice a day.

And now we come to the reptiles, those giant dinosaurs of the later Paleozoic and the Mesozoic periods, existing as monarchs of their universe for the vast period of a hundred million years or so. The appearance on our earth of those colossal, lumbering, mostly savage but well-nigh brainless monsters is perhaps the most amazing thing in the world's history—except perhaps their comparatively sudden and complete disappearance. We have all seen pictures of these giants, some measuring up to one hundred and twenty feet or so from tip to tail, some growing ridiculous armour, and all with infinitesimal brains. Stegosaurus had somewhere around his fat hips an enlargement of the spinal cord (giving him reflex actions for his tail and hind legs) which was actually bigger than his brain!

We write scornfully of these bygone beasts, relegated so long ago to Nature's dustbin; in what way, then, were they a step forward in Life's effort to be master of its environment? The answer is that they had achieved, at least at the end of their span, complete emancipation from the water-life. Besides acquiring that hard skin they had learnt to lay eggs—not merely spawn into the water—and could walk—yes, and even run!—on the land.

But what of the air? After all, in the sea you have the benefit of three dimensions in which to disport yourself; otherwise, unless you launch out into the ocean of the air, you have only two.

The insect is the first and greatest conqueror of the air. He comes on the scene somewhere about the same time as the amphibian and the terrestrial, stiff-stemmed plant. And he too, as it were, clambers out of the sea: he evolves from those trilobites and sea-scorpions and other jointed denizens of the early seas.

How does he solve the difficult problem of breathing air? He does it by the fairly efficient and very elementary method of a large number of very small air tubes which terminate in simple outlets or "spiracles" in his body and at the other end take the oxygen to his blood stream. This however has one great disadvantage: it is efficient for a body of small bulk but quite useless for anything weighing more than a few ounces. Insects, while the comparatively few types of amphibians and reptiles were lumbering about the landscape, were increasing if not in size yet with amazing rapidity in kind and number, and in adaptability to their environment and skill in flight. It is almost certainly nothing but this overruling inability to grow to any large size which prevented them from becoming the lords of the earth.

But there are other than insect wings. At least the smaller reptiles managed to conquer the third dimension. It was done first in just the same way as later the mammalian bat managed it, by growing membranes stretched across from limb to limb. The rocks have left behind the skeleton of those queer nightmarish beasts, the pterosaurs (Greek for winged reptile). The pterodactyl (wing-fingered), one of this type, with no tail rudder, had a great toothed beak; he probably dived down "spot on" for fish. The pteranodon had a wing span of as much as twenty-five feet. Many of these early winged reptiles could not so much fly as vol-plane and must have had to climb cliff or tree laboriously, as the tobogganist reclimbs the hill, to achieve just one glorious glide.

Life however was not content with this half-way house, this clumsy second-best attempt at mastery of the air. Later the rocks give us Archae-opterx (the hyphen is put in to show how it is pronounced and that it means ancient-winged), a cut between a reptile and a real bird, with feathers and yet with claws on the front margin of its wing and with a big clumsy lizard-like rudder of a tail. From this there evolves slowly the warm-blooded bird proper, with its miracle of a wing, from the soaring master-pinion of the eagle to the tiny pulsing membrane of the humming bird, beating faster than the eye can distinguish.

But back to the main stream of evolution. We have reached the reptiles. If you want to appreciate how really low in the scale is even the reptile, how unresponsive to his environment, how little master of it, take the opportunity to watch some of their breed in any Zoo: the lizards, the chameleons, the crocodiles. Except for a few sudden automatic reactions, they seem only half-alive. They will stay quite immobile for an incredibly long time.

And notice how the Reptile House in any Zoo is kept hot. The reason is, of course, that these creatures are not "warm-blooded", or in other words they have not the power to vary their blood-heat from the surrounding temperature, so that if the weather freezes they freeze too. That is a tremendous disadvantage. Some cataclysmic freeze-up of sixty or so million years ago may well have been the doom of the dinosaurs: they had not the intelligence or speed or adaptability to get to the climates where reptiles can thrive, But before they disappeared, disporting itself innocently amongst the giants, was the first mammal. What has the mammal got that the reptiles haven't got? It has a "warm-blooded" system which can keep its body at an even temperature in extremes of heat and cold; it brings forth its young alive instead of laying eggs and leaving the sun to hatch them (though some reptiles had achieved that advantage); and it *suckles*—feeds from its body, rears, and nurses—its young.

Perhaps the first mammals or near-mammals were a little like the queer atavistic relic that still hangs on to life in Australia: the duck-billed platypus, an animal that has mere rudimentary glands for suckling and that lays eggs. Whatever the first mammals were exactly like, they were small but they were successful. They inherited the Earth.

They inherited the Earth because of those mammalian advantages which we have listed. The results were better adaptability to environment, quicker reactions to its possibilities and dangers, better *teachability*, and better brain. Particularly better brain.

One sort was especially good in developing brain, the tree-climber. For if you are going to do that you need something better than a foot at the end of your forelimbs, you need something to grasp with; if you are going to be active and nimble amongst the branches and do not want to break your neck, you need good eyesight. Certain types of mammal—types that have blossomed out into the lemur and monkey families—tried this experiment of climbing up into the trees, and succeeded beyond expectation. Go to a Zoo again and see some of these animals, quick, intelligent and pretty little creatures: the galago or bush-baby, or that tiny animal with prehensile hands and immense bulging eyes, the Spectral Tarsier. He, in a most startling manner, has developed stereoscopic vision, the power to see a single image with two eyes and to see it very clearly and with an effect of comparative distances. Hand and eye, skill of hand and eye: Life achieved these *and improved its brain tremendously in the process.* For, rather in the same way as flower and insect have helped each other to evolve, so the need to use hand and eye more cleverly exercises the brain in the production of skill, and the increased brain in turn enables eye and hand to make further advances.

But the mammals obviously did not inherit the Earth only by climbing trees. They did a great deal else. They fitted themselves to a great variety of environments. The Ungulates, or hoofed animals, lost their toes and grew long legs, and became wild, frisky runners in the steppe lands; they even gave birth to long-legged animals that stood and almost ran from birth and so could seek safety in flight. Their enemies the carnivores, or flesh-eaters, developed long jaws and efficient tearing and piercing teeth—the sabre-toothed tigers overdid it and perished for their folly. The bats did over again what the pterosaurs had done and went back to the air. The whales and seals and porpoises and manatees even re-adapted themselves and reconquered the waters.

But, we must next ask ourselves, were any of these special adaptations a step forward? The answer is largely "no!" And that brings us back to the tree-climbers and the advance in hand and eye and brain that that sojourn gave them. For even to live in trees is something of a special adaptation: a further step is needed to help stimulate the growing mammalian brain.

For remember that it is above all in brain that the mammal excels. And brain gives the power to *teach*. It is a good thing in the end, life finds, for the young to take longer to grow up. It is a good thing to replace automatic instinct by something better but harder to attain, a reasoned and intelligent and sensitive reaction to environment. It is good, too, to love—we need not necessarily jib at that word when we are talking of science. The mammal mother (and the bird mother for that matter) teaches, succours, loves her offsprings; she will sacrifice herself for them.

Finally the further step is taken. It is the step down from the tree to the ground again—*where Life learns to walk upright.*

That is the last great step and it is not an easy step: our mammalian, vertebrate, four-limbed body was not first designed to walk upright and we still suffer from weaknesses and potential bodily troubles from doing so. But it was worth it. Whatever it was that had the courage to come down from the tree and to face a world that had the tiger and the mammoth and the snake and the bull bison—whatever it was, whether monkey, ape, ape-man—he had this advantage: skill of hand and eye, and hands that were *free to be used*, being needed neither for walking nor for climbing. They were free to pick up a stone and throw it—with purpose. They were free to chip a stone and sharpen it. They did so. Man, *the Tool-Making Animal*, had arrived. The rest of the evolutionary story is what we call history. . . .

But if that is a sketch of the facts of Evolution, we still have not touched on the How and the Why of Evolution.

The Why is not a matter of Science, but rather of philosophy or of religion. It is not a matter of knowledge, it is a matter of exercising one's powers of intuition or of reasoning—a matter of wisdom? The Why of Evolution therefore we leave strictly alone. The "How" brings us back to Darwin.

Two great facts struck Charles Darwin in working out his theory of evolution. One was the struggle for subsistence, or the struggle to keep alive. The other was Natural Selection. By Natural Selection we mean the fact that all forms of life produce in varying degree a greater progeny than can ever hope to grow up and survive, and that Nature inexorably wipes out the weakling and so automatically selects the strongest and most adapted for survival. And so we get the How of Evolution to be, in the classical phrase: the survival of the fittest by means of natural selection. That is the machinery by means of which Evolution works.

Now to appreciate this properly we must get into our heads an idea of the amazing profligacy and wastefulness of Nature. Most forms of life proliferate with an overwhelming and extravagant generosity; and, by and large, the lower the form of life, the greater the wasteful extravagance. One has only to think of frog spawn, or even the inconvenient multiplication of pet mice, or the thousands upon thousands of seeds up the long stem of a foxglove, or of how many oak trees there would be if every acorn grew and survived. Then most bacteria proliferate merely by splitting, and they do it as often as every twenty minutes. In that time one will become two. Then two will become four, four become eight, and so on and so on.

The increase is what we call geometric progression. It does not need much calculation to see that in a very short time the earth at that rate would be knee-deep in bacteria. It *would* be, if there was not a terrific mortality all the time. It is the same with the mouse, the tadpole, the oak tree; most acorns, for that matter, do not even get a chance to start because they do not fall on favourable ground. In plants, only the seed lucky enough to find itself in the right environment gets a chance; in animals only the strongest, or the quickest, or the most intelligent survives.

This business of propagating the species, of seeing that life goes on, is obviously of tremendous importance. It is a major phenomenon of life. Life is very dear and desirable. It is also very tough and very tenacious. There is a deep, almost terrifying drive and power and urge about it all. But notice that it is not so much an urge to keep the individual alive as the *species* alive. The mammalian mother will sacrifice herself—for her young. The microbe sacrifices whatever individuality it has, in order to split itself into two and continue. The eel exhausts itself in proliferation. The drone dies in fertilizing the queen bee, the male scorpion is eaten by his bride; yet neither bee nor scorpion seems in the least hesitant about becoming a bridegroom, nor the eel in making his wonderful instinctive way across half the world to its breeding ground in the Sargasso Sea.

We have arrived at Sex and the sexual method of making life continue. Now in this matter two things must be realized very clearly.

The first is that sex in plants and sex in animals are really very much the same thing: the plant has pollen, the animal has the sperm with which to fertilize the egg cell of the female. The second point is that sexual propagation is not the only method nor even the original or simple method. The lowest forms of life merely split into two; other forms are both male and female—hermaphrodite—and fertilize themselves; some most curiously have two methods, both sexless (or "asexual") and sexed, and are able to use either method. Ferns and mosses first produce spores which grow without any fertilization, and these in turn produce both sperms and egg-cells: an alternation of sexed and sexless generations. Sex in fact is not a necessity for life but a *refinement*: instead of half the body, as in simple splitting, carrying across to the next generation, one small and specialized part is developed in two different bodies, and these unite and form the body of the next generation. It is a refinement which Nature seems to have striven after and perfected.

Now why should that be? For answer we come back to the second part of that phrase explaining the method or machinery of Evolution: "by means of natural selection".

Natural selection must have something *to work on*. If all of a progeny are the same except for variations in strength, or health, or luck in finding agreeable surroundings, then admittedly some will survive and some will not. But there is no scope for change: each generation will succeed the other with dull regularity and we shall get no further. But if every now and then an outstandingly different individual arrives—the equivalent of a genius in man we might say, a type which can blossom forth and conquer new environments, or survive in a changing environment—*then* we have got somewhere. And it is not difficult to see that where the next generation comes from two preceding individuals and not one, when it can inherit in variety the characteristics of both its mother and father, then the chances of the different individual and the outstanding type arriving for Natural Selection to work upon are greatly increased.

We have reached here the borders of a whole large scientific subject on its own: *genetics*, the science of birth and heredity. It is a fascinating and a difficult science and a science that is growing and changing every year. The Abbé Mendel is the great name in the early history of this science, an Austrian priest who in the quiet of his garden of a century ago experimented, with the utmost patience, upon the heredity of sweet peas—for remember once again that all life, vegetable as well as animal, is subject to the same methods and laws in sex and heredity.

But Mendel only began. Now the geneticists have taken it all very much further. They have discovered *chromosomes*, which are those amazing microscopic "beads-on-a-string" contained in both the male sperms and the female eggs and which, in ways only as yet half guessed at, govern the characteristics that the baby—be it human, beast, fish, insect or sweet-pea—will inherit. One of the most recent ideas about chromosomes is that they are influenced by those very short-wave "cosmic rays" which we mentioned in the chapter on Physics, and that just possibly atomic energy will some day help to give us control—a very dangerous control—of the mechanisms of heredity and of life itself.

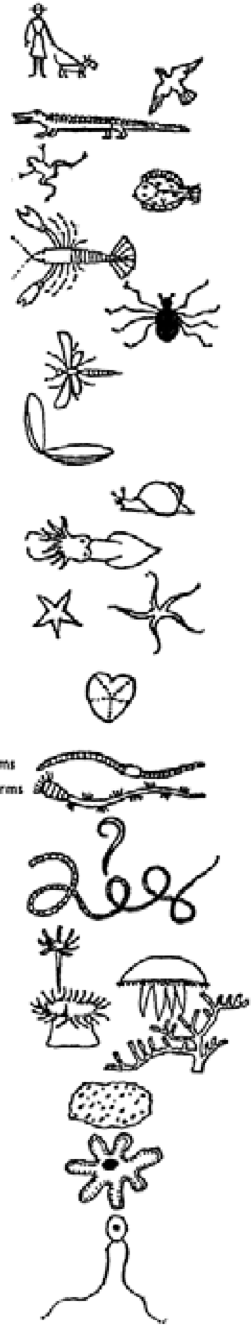
Now one last point about evolution before we are led on to the second of the chapter's three main headings, the Variety of Life. It is this: that in tracing the story of evolution we were following the *main* stream only, the trunk of the tree. But there are many tributaries, innumerable branches. Life, as we have just seen, struggles to proliferate and adapt itself to any and every environment. It fills the corners of the Earth; it specializes for that purpose.

But, as we have seen, the main stream of life that led to Man has not so specialized; or if you like to put it another way, it has specialized in adapting itself not particularly to a particular environment but generally to as wide an environment as possible. Men cannot run so fast as a deer, swim like a fish or a sea-lion, fly without mechanical aid, use sting or poison or tear and rend to protect themselves, they cannot lie fallow or desiccated for years and then come to life again. Other forms can do those things supremely well—*one* of those things. There have found their niche and will no doubt be content to stay in it just so long as it continues to exist for them. It is that urge again, that urge-towards-life. It fills every different corner of the world with its *variety.*

The varieties of Life, the different kinds of life: how exactly are we going to *classify* them? Birds, beasts and fishes? We can do better than that: fish, amphibian, insect, reptile, bird, mammal. We can do better than that even. We can classify by environment. That is one way. Or we can classify by *pattern*; that is the way we will try here. Another word for that is "ground plan"; another would be "Nature's experiments". Life, after all, does not necessarily have to have a head and a backbone and four limbs more or less at each corner, or a stem and a flower and root and green leaves. It may be a starfish, with a mouth and stomach in the middle and five radiating limbs, it may be a lobster with its skeleton *outside*, it may have six legs, or eight or a hundred, it may be a toadstool or a yeast, or a lichen or a microbe, a self-respecting fender-for-itself or (from the strictly human viewpoint) a horrible parasite. Only the smallest fraction of the different types of life do we meet in our everyday urban lives.

THE PATTERN OF LIFE 1. The Animal Kingdom

- VERTEBRATES
  - mammals
  - birds
  - reptiles
  - amphibians
  - fish
- ARTHROPODS
  - crustacea
  - arachnida
  - insects
- MOLLUSCS
  - bivalves
  - gastropods
  - cephalopods
- ECHINODERMS
  - starfish
  - sea urchins
- WORMS
  - segmented
    - earth worms
    - marine worms
  - round
  - flat
- COELENTRATES
  - polyps
  - jelly fish
  - sea anemones
  - corals
- SPONGES
  - sponges
- PROTOZOA
  - amoeba
  - flagellates



Now there is no need, in order to be an expert in all this, to know the Latin names. A word about them first, nevertheless. We see a picture of an English fox, and read underneath the caption, *Vulpes vulpes*—which seems rather foolishly repetitive. Yet it is not. For exact classification is an essential beginning. And there *are* other sorts of fox—the pretty long-eared fenec fox, for instance, to be seen in Zoos, which is *Vulpes zerda.* The first name here is the name of the genus (it is always written with a capital) and the second name that of the species. Species, one might say, differentiates animals that cannot breed together freely and easily; you can sub-divide even further into sub-species—when you get three Latin names in a row. But there are also divisions going the other way, wider and wider. These run from Genus to: Family; Order; Class; Phylum; Kingdom. And to give those some significance, this is what our friend the common fox, or *Vulpes Vulpes,* is: *Kingdom,* Animal (as opposed to Vegetable!); *Phylum,* Vertebrate (the ground-plan that has a backbone); *Class,* Mammal; *Order,* Carnivora (flesh-eater); *Family,* Canidae ("dog-tribe"); *Genus,* Vulpes; *Species,* vulpes; *Sub-species,* crucigera. All of which pens him down pretty closely.

The same applies to plants. And a little knowledge and appreciation of the system will enable you to amaze the innocent and ignorant. It will not do very much else however, unless you are going to specialize.

This chapter, on the other hand, is the reverse of specialization. We want to keep the wide view and, as it were, the eyes of innocent wonder; we want to see the *implication* of the facts of Nature. We shall, then, review the Varieties of Life, not to learn their Latin names by heart, but rather to appreciate how great and marvellous that variety is, how prolific and inventive Nature can be. We give these Varieties first in the shape of two Tables, showing the Phylum on the left and on the right some of the more important or significant of its sub-divisions. But, since it is the implication we are after, we shall elaborate on these tables; we shall, on occasion and of set intent, digress.

The thing to appreciate of the first Phylum, the Vertebrates or back-boned animals, is not so much how successful an experiment it has been on Nature's part, as that it is not the only experiment—which the unthinking might almost imagine it to be since it covers so much that is familiar. Certainly the four appendages of the central backbone vary in their form and use: arm and leg, hand or hoof or paw; wing, flipper, fin.

Arthropod (it means jointed limb or foot) is a type of life that has put its armour on. It wears—and this is not being facetious but soberly truthful—its skeleton outside. This is a safety-first device which yet has its disadvantages. If you want to grow you must temporarily shed your armour—in which case Heaven help you if your enemy finds you in that state—or you must, like the insect, split your life into two, one half being soft and retiring and grub-like and the second splendid but ungrowable. There is also the difficulty of muscles, and of flexibility. Our own bones work on a ball-and-socket principle and our muscles tie themselves on to our bones and use them as levers; the Arthropods have to have their whole limbs jointed, rather like a knight's armour. The lobster, biggest of the arthropods, shows best how amazingly different a ground-plan can be: blue blood, liver and kidneys near its head, equivalent of teeth in its stomach, and instead of hands "a whole battery of implements, including ready-made knives and forks".

The whole army of insects come within this phylum of the Arthropods, as do also the *Arachnidae* (eight legs instead of six) which comprise the spiders, ticks and scorpions, together with a fortunately extinct species, "the bullies of their world", the six- or eight-feet-long sea scorpions of the early Paleozoic, pre-reptilian age. Yet, even so amazingly different physically as these forms of life may be from our own, the most significant fact of all is really their difference mentally. They are in a word instinct-ridden. And so their actions and their way of life, their behaviour, is something so strange to us that we find it extremely difficult to understand. It is something which will not only amaze us but puzzle and worry us, unless we realize from the start that we have need to put aside all preconceived ideas gathered from thinking of our own behaviour. It is almost certainly waste of time being sorry for a worker bee working himself to death; it is probably mistaken to say "Go to the ant, thou sluggard!" because the ant can surely never feel lazy and thinks even much less than the most confirmed Nazi of disobeying orders. In fact it is obviously wrong to say that the ant "thinks" in that way at all. This business of insect behaviour is most fascinating; many great men have written fascinatingly about it: Forel; in particular Henri Fabre; and, writing more philosophically and less scientifically, Maurice Maeterlinck.

To come back to our Table, the Molluscs have taken even more of a safety-first line than the Arthropods. Their soft parts—and their name comes from the Latin for soft—they encase in a shell, and they sacrifice a large part of their mobility in the process. The octopus is the most adventurous and the fiercest; he has grown around his shell and left it embedded in the middle of him. And whether he became fierce because he lost his shell or vice versa it would be interesting to know.

Echinoderm is Greek for hedgehog-skinned and covers a number of rather beautiful prickly and feathery forms of sea life, the most familiar of which is the starfish. The ground-plan is five limbs radiating out symmetrically from a centre; it has been nowhere near so successful as Nature's four-limbed plan.

Of worms there is abundant variety. Some that live in the sea are beautiful, our familiar earth-worm is supremely useful, but for the rest the worms are largely disgusting. Disgusting, that is to say, from the purely human angle. They are mostly parasites, living within the bodies of other animals (including sometimes ourselves). The ingenuity with which they have adapted themselves to this life and with which they, as it were, see to it that they find an innocent host to live in, is truly amazing and, from a purely objective and impersonal angle, beautiful. But it is a beauty that we can hardly admire. These worms represent the urge-towards-life, the Life Force if you like to call it that, taking a blind alley and a very lazy path.

With the Coelenterates (it signifies having one "body-cavity" only) we come to two of our most important "implications". These are firstly that there is no clear dividing line between plant life and animal life, and secondly that *individuality* as we understand it—one animal, one entity—is by no means a rule or even a necessity of Life.

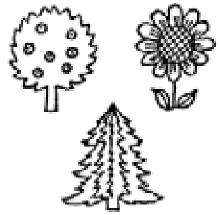
Take the second and more difficult of those conceptions first. Superficially there can be no question about it, at least so far as we humans are concerned: we are each of us individuals and that is that. But it is easy to plant a doubt in our minds. Think of the fact—we shall learn more about it in our Physiology chapter—that our own body is made up of myriads of independently growing and multiplying cells and that some of them—the phagocytes of our blood for instance—lead a remarkably independent existence. Or you may read about an ants' nest or a beehive losing its queen, and how at that catastrophe all cohesion and purpose seems to disappear; there will come to you then the idea that it is almost as if personality and individuality resided in the nest or hive as a whole and not with each ant or bee. That is a queer thought.

Take it from another angle. Even further up in our table of life-patterns some queer things happen. If a starfish loses a limb—almost a fifth of itself—it can grow another with apparent ease. Then there is a little marine worm that goes much further, new individuals growing on at the hinder end of the body—a chain of as many as forty. At odd times the last of the chain becomes rebellious, metaphorically digs its toes in —and literally tears itself away. Where is individuality in that string of forty heads and tails?

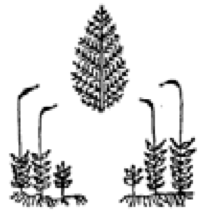
But the Coelenterates—stinging, floating, swaying life of the sea—have even less easily defined individuality. They are, essentially, colonies of cells collected together, one might say, for convenience. Obelia is a tiny plant-like animal, rather like a miniature of the familiar sea anemone, which lives by stinging to death and digesting minute crustacea and the like which come near to its flower-like mouth. The cells

2. Vegetable, near-Vegetable and the minute

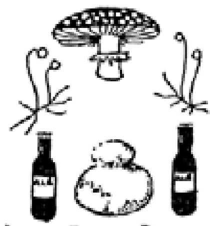
SEED-BEARING PLANTS
- CONTAINED SEED
- NAKED SEED (CONIFERS)



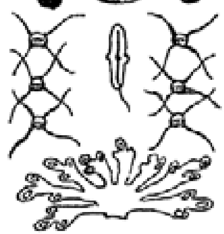
SPORE-BEARING PLANTS
- FERNS
- MOSSES



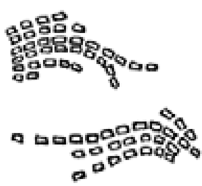
FUNGI
- FUNGI
- MOULDS
- YEASTS



ALGAE
- DIATOMS
- SEAWEEDS



BACTERIA
- FOOD BACTERIA
- SOIL BACTERIA



DISEASE VIRUSES
- (TOO SMALL TO DRAW')

which are the "bud" feed, by their predatory activities, the rest of the cells which form the "plant". But then something even stranger happens, other cells bud off and become free-swimming miniature jellyfish ("medusae") capable of forming new colonies. A terribly stinging and highly coloured jellyfish called the Portuguese Man-O'War has in something the same way cells-that-eat, cells-that-sting and cells-that-marry.

These coelenterates in fact are cell-colonies *without* a central directing brain such as our body has. Individuality, as we understand it, has not in their case arrived.

Now for our second implication: the haziness in the division between animal and plant. It is true of course that some of the resemblance to plants of the sea anemones and obelia and so forth—the flower-like "mouth" for example—is only superficial. But the resemblance does go deeper: immobility, for instance, and the power to bud off. The sponge—an animal resting on the bottom of the sea whose skeleton we use in our bath—was long thought to be a plant. But then it was noted that by means of tiny waving hairs it passed through itself a gentle current of water, and fed (like so many of the lower sea animals) on what that water contained.

Nevertheless, even if the dividing line between animal and plant is hazy, it does exist; and we shall do well now to turn to our second Table and to consider the implications that are worth our notice there.

We shall arrive at our first by seeking to define what does in fact constitute a plant. These are its two main characteristics, from which all others flow: it grows but it doesn't move about; it feeds, but not as we understand feeding, that is to say through some sort of a mouth.

Now, when we enquire how a plant does feed we come up at once against an outstanding miracle of Nature. A plant can do what neither man nor any other form of life can do; it needs only water, carbon dioxide from the air, a few chemicals, and light, and it can feed and grow. "Take," says that best book of all on popular biology, *The Science of Life*, "the most famous chef in the world, give him water, a handful of nitrate of lime, a teaspoonful each of nitrate of potash, phosphate of potash and sulphate of magnesia, and a trace of iron (such as the rust from an old nail); what sort of dinner could he turn out for you from that?"

The plant does it by means of *chlorophyl*, the green substance in leaves, which has the remarkable ability to utilize sunlight to build up from those elementary chemicals the cells and tissues of its body. That is the miracle of the plant: chlorophyl.

This remarkable ability to build up from light (*photo-synthesis* is the scientific, that is the Greek, name for it) means that a plant does not have to move, as the animal world has to move, to find its food. It has, then, no need for limbs, or heart, or brain, or consciousness. What it does need to do is to move within itself: grow roots to search out moisture, grow many leaves, and spread them out insistently towards the precious light. It does that, as we know, superlatively well; each and every form of vegetable life struggles to get its fair share and more than its fair share of what the sun has to give.

In two other ways the plant differs strikingly from the animal kingdom. It too is built up of cells; but since it needs (as soon as it has climbed out of the water) those stiff stems and trunks to support itself, it encloses its cells in a hard case or box of "cellulose". And secondly its seeds have grown that hard protective case we spoke of, so that, unlike the animal's fertilized egg, it can lie fallow almost indefinitely and propagate when the right environment happens to come along.

And now—having roughly defined a plant, and leaving its divisions very sketchily to our Table and in more detail conveniently to the professional botanist—we have seemingly to contradict ourselves. The contradiction is this: that there are plants which do *not* produce chlorophyl.

How then do such plants live? The simple answer is that they live on other plants. They are either parasites or saprophytes, the latter being Greek for a plant which lives on dead (that is to say decaying) matter. They are the moulds and mildews, the toadstools and the yeasts. They are rather animal-like in that they feed by exuding a digestive juice and sucking in a sort of "predigested soup" in return.

They do this by the medium of a felt-like network of tiny protoplasmic threads, which burrow into and spread through the vegetation on which they are living. That network is the distinctive attribute of fungi and moulds: when you see a mushroom you are only seeing the equivalent of the fruit, the more essential treadlike part you will see if you buy "mushroom spawn". All that is, to say the least of it, an unexpected pattern of life.

Yeast is more than that; it is extraordinary. It is also very useful and very comforting to man. Yeast cells—each and all of them—live on sugar, decomposing it and giving off carbon dioxide and alcohol in the process: we use the one to make bread rise and the other to make beer ferment. You can buy an ounce of yeast for a few pence, and you will have bought some five thousand million cells, all willing to work for you if only you will spare them a little sugar.

We come now to the very small. The best thing to do here, in order to avoid confusion of mind, is really to stop thinking in terms of either animal or vegetable at all. Some of these forms of minute life are admittedly much more vegetable than animal, some the other way about. But then they will also have contradictory attributes. What is less confusing and much more significant about them is that they are usually very simple, and very often unicellular or made up of one cell of life and one cell only.

Often they are *flagellates* (Latin: *flagella*, a little whip.) They have, that is to say, a long hair, or hairs (called also "cilia"), which they can wave about, often in queer and unexplainable rhythmical ways, in order to move themselves along. This *cilia* idea is incidentally a favourite one of Nature's; sponges and some molluscs use it to attract food to themselves, our own body uses it—in the air passages of our nose and throat for instance.

The *Algae* (Latin for seaweeds) come legitimately under the heading of very small, for seaweed one can regard as a flagellate that has decided to live in a colony. Seaweed does not have seeds, but (more like an animal) male and female cells where the male is "flagellate" and active. Some algae do not form colonies. The green on the shady side of trees is made up of a form of algae; and in any damp sunlit place and in particular in the top layers of the sea there are absolutely uncountable millions of little shelled life-specks called diatoms, which form the staple food of some fish (and so of other fish that eat fish) and have been called "the pastures of the sea".

Then there is another single-celled type of life, animal rather than vegetable if one must make the division, and so appearing perforce for accuracy in our first Table: the *protozoa*. These again may move by little whips or hairs, or they may glide or as it were pulse themselves about as does that elementary jelly-speck, the amoeba. They all thrive in any form of dampness: survivors, we may say (as their name, "first-life", implies) from the dawn of the living world, and of no very great significance today.

But there is a form of minute life that has *tremendous* significance; it is the microbe or bacteria. That significance, let us say at once, is *not* that some of them produce diseases in animals and ourselves.* The accent on disease comes more from the last pattern of life on our Table, the *Viruses* (Latin for poison), so small that not only they cannot be drawn but they cannot be seen and can pass through the finest filter made. No; the significance of the bacteria is that (rather like the fungi) they make it their business to deal in decomposition and decay.

Far from the microbes as a whole being inimical to Man, he could

* The generalizations here are perhaps a little dangerous. Both protozoa and bacteria cause some of the worst diseases—sleeping sickness and malaria for instance; tuberculosis and diphtheria.

not do without them. They are, to put it as succinctly as possible, an essential cog in the wheel. What wheel? The Wheel of Life. We come with that to the third and last of the three essential parts of this long chapter: Interdependence.

Life, the whole of life on this planet, has a Cycle of Interdependence.

Think first of animals. They either eat green stuff—vegetables—or they eat other animals who eat vegetables; in the words of the Bible, "All flesh is grass." And we have already seen what vegetables live on: light and water and chemicals. But if that were all the picture, the earth by now would be denuded of chemicals and also littered with the carcasses of the animals who had eaten the vegetables.

That is a strange thought but a very pertinent one. Something is obviously needed to complete the cycle "dust to dust". We know the answer of course: decay. But it is decay caused by millions upon millions of bacteria, completing the cycle and breaking down both animal tissue and the vast residue of uneaten vegetation, back to the plain elemental chemicals of the earth.

The microbe is very small, less than a hundredth of a millimetre long. But it breeds, as we have said before, every twenty minutes or so, and it is tough—if it doesn't like its environment it can go indefinitely into a desiccated state and await its opportunity to come to life again. We owe a lot to that toughness. We are dependent upon the microbe, as much as it is dependent upon us in this grim cycle of life.

And yet it is hardly right to call it grim; it is hardly for us to pass such a facile judgment. For the *individual* to die is hard without doubt. But it is abundantly clear that Nature does not concern itself with individuals. The antelope leapt upon by the lion meets death; but the herd is kept alert by danger. Then the preying of one type upon another may help a third: bird keeps insect down and benefits the animals (ourselves included). The right outlook is to see life as a perpetually swaying *balance* kept so by a struggle by all the forms of life to continue and to live more abundantly.

That conception of a swaying balance brings us to one last idea and branch of the science of biology before we close the chapter.

It is the branch called *ecology*, derived from the same word as economics, which in Greek means "housekeeping". It is the larger housekeeping, the very largest. For Man has the increasing ability to control that swaying balance of life; and the science of ecology teaches him to observe intelligently how that balance does sway and operate, so that he can the better control it.

Nature, he observes, tends to reach an equilibrium, but an equilibrium continually disturbed. We see it, for instance, in a simple way, in the bombed site. There there has certainly been a disturbance: all life has been blown away. But life comes back, fills up the gap. First the loose-strife perhaps, the patient plant-seed waiting its opportunity. Plants spread, compete against each other. Insects get a chance, birds get a chance because of the insects. . . .

And man needs to possess a knowledge of all this because either he can intelligently sway the balance the way he wants it to go, or, on the other hand, by his unintelligence he may do much more harm than good. He may be greedy—and work the patient earth to death and so create such shameful monuments to his folly as the dust-bowls of the Middle West of America. Or he may have been no more than short-sighted—as he was in Australia when he introduced the rabbit and prickly pear, to find each of them a plague.

A good example of how delicate is this balance of Nature and how difficult to control is given by the prickly pear. The larva of a certain moth was found useful in Australia in killing off the pear. But, introduced into South Africa, it was *not* successful: it met its own enemy in the ant. Nor does it always pay to kill the killer of the life you wish to retain. A certain kind of grouse was dying off in Norway; men therefore destroyed as many as possible of its enemy the birds of prey. But then it was found that the real cause of the falling off in the number of grouse was a disease and that the birds of prey were merely killing off the weaklings and most disease-ridden. Less birds of prey: more disease in grouse: less, and not more, grouse as the result! Cause and effect in these "food chains" can be unexpected. Darwin was the first to startle people with them. His classical example was the apparently ridiculous statement that more cats were likely to mean more clover. His chain was: more cats—less field mice—more humble bees (field mice destroy their nests)—more clover (by pollination).

One reason for creating "Nature Reserves" in this country is so that scientists can study their ecology. . . .

There we must leave Biology, and with great slices of it untouched: genetics, embryology, the interaction of heredity and environment, plant evolution, animal behaviour.

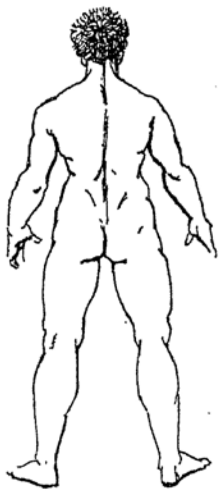
For the layman, to put it at the lowest and in a negative way: there will be a gap in his knowledge, and so a falsity in his outlook, if he has not at least stowed away in his mind an appreciation of those three things, the story of the evolution of life, the variety of life and its urge to fill every corner of the earth, and finally, life's interdependence. That much is essential.

BOOKS: As with Chemistry and Physics, the school text-book will not help very much, not because it is bad but because it is designed for use in a class and with a teacher and with personally directed experiments. But *Man and Other Living Things*, by Francis G. W. Knowles (Harrap), is at least one exception; it covers Physiology as well. Another is *Life*, by Sir Arthur Shipley (Cambridge University Press).

As an introduction to animal, or rather insect, behaviour and to the kind of book that needs no detailed knowledge to be appreciated and is good literature as well as good science, there is *The Insect Man*, by Eleanor Doorby. It is meant primarily for children and is indeed published as a children's *Penguin*, but no grown-up need feel condescending towards it. It tells of the life of Henri Fabre, whom we have already mentioned, and includes quite large excerpts from his writing. Another naturalist who has achieved literary recognition is W. H. Hudson. There is for instance his *Far Away and Long Ago* (Dent), telling the story of his own early life on the Pampas and his great love of birds.

But the main and outstanding recommendation for this chapter is the book already mentioned, *The Science of Life*, by H. G. Wells, Julian Huxley, and C. P. Wells (Cassell). The best edition if you can get it is the one compiled from the original fortnightly parts, since it has the full range of diagrams by Horrabin and pictures by Brightwell. This book covers an immense amount of knowledge. But it needs no prior biological knowledge to understand it. Since this chapter owes a great deal to it, it would be sheer effrontery and savour of quite unjustified patronage to praise it.

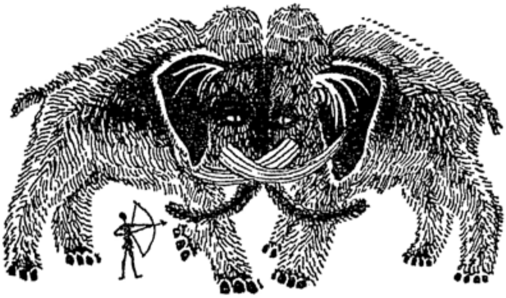
MUSEUMS: No one should miss an opportunity of visiting the Natural History Museum at South Kensington, London; it will bring biology to life for him.



Man in Outline. Life's Most Successful Pattern

PART TWO

Man Himself



CHAPTER VI

THE HUMAN STORY

(Archaeology; Pre-History)

THE plan of this book is to cover, as a pianist does the long white keyboard of his instrument with his two hands, the whole gamut or scale of knowledge and learning and culture. The plan is to do so by a survey of, first Man's environment, second Man himself, and third Man's influence upon his environment. One might almost put it mathematically:

(*a*) Man's Environment;
(*b*) Man;
(*c*) $\dfrac{\text{Man}}{\text{Environment.}}$

Or in a humbler way,

(*a*) Man's Environment;
(*b*) Man;
(*c*) $\dfrac{\text{Environment}}{\text{Man.}}$

It would even be possible to go further, and say that History is the story of turning that fraction at (*c*) upside down from the humble to the less humble way of putting it.

That being so, Part II brings us first to Man's story, which is History.

How to tackle such a huge subject as History in a book like this? At school we mostly learn our own country's history—without much of the inestimable advantage of being able to taste and savour it by travelling to the places where it actually happened. We do well to make good that lack when we are grown up and are a little freer and more mobile. *Here*, in this very street, Latimer and Master Ridley lit such a candle with their own poor bodies as shall never go out. *Here*, on this very beach, the great Julius Caesar landed—and was so ineffably foolish as to let the tides of the English Channel wash away his fleet. There must be some thrill in that sort of thing to the most unimaginative.

For some, history lights up most easily in the reading of Lives, biographies: that idea we shall come back to in the chapter on literature.

But for others, history lights up best in a survey of the whole colossal sweep of the thing: the story of the adventure of mankind, from the time when he became recognizably Man to the present moment. It has its added attraction because to many it is often a remarkably fresh conception. School is too apt to teach us in neatly wrapped and quite separate little packets: Bible history, Greek history, Roman history, English history. If ever there was need to obey that command "Only connect!" it is here.

And so we do obey it! There is no other way out. At the risk, then, of overweighting the book, in one long chapter—or rather in two, since a breathing space is expedient—we shall try to cover the story of Mankind. There will have to be sweeping generalizations, particularly towards the end; but even a generalization that is violently objected to can stimulate thought. And there is at least this to be said in defence: if it were not written here, then many detached and disconnected pieces of it would have to be written elsewhere, in speaking of art, of mathematics, of architecture, of the growth of the conception of law and order, and so forth. Indeed this double chapter might equally well serve as an introduction to Part III, "Man's Achievements or His Influence on His Environment". Nevertheless, it is probably better in its earlier place—being in fact, as the last chapter suggested, really a continuance of the evolutionary story.

History, then, as an extension of Natural History.

Now Natural History is the story of the various species of life struggling to adapt themselves to their environment. Man continues the process. But he has those two inestimable advantages that we said Life had gained by climbing the trees and then coming down again: the human hand and the human brain. And so he invents *tools*. He invents equipment. He invents what may be called "detachable" equipment:

the spear and dagger instead of the sabre-tooth of the tiger, the spade or gouge instead of the specially adapted foot of the mole or rabbit, the knife and fork for that queer specialized battery of appendages of the lobster, and so on. Mankind did not specialize, *except in brain*, with the consequence that he is not adapted to any particular environment, but can adapt himself to almost all, and can, as we have said, go further and turn the tables by adapting environment to himself.

Near-men, "something-like-men", hominids as they are sometimes called, appeared on this earth somewhere about half a million years ago. Geologically, that was near the end of the pliocene (more recent) period and towards the beginning of the pleistocene (most recent). The giant reptiles are already in the world's dim past (do not forget that!); the mammals have been developing, experimenting in shape and size, settling down, over the last hundred million years or more. The scene is set for the last act. As we watch we have to slow down the speed of showing the flicking of the years, because *change*, or the rate of things happening, is speeding up; nevertheless for a long while yet the rate by modern standards is painfully, achingly slow.

For some hundreds of thousands of years, ape-men and near-men wandered the earth, a sparse and apparently unimportant species. Yet they had played and won the first trick by the use of their hand and brain: they had invented a tool, the chipped and sharpened flint.

We talk of eoliths, of paleolithic, mesolithic and neolithic cultures. They all refer to different ways of making and using flint tools. *Lithos* is Greek for a stone (i.e. a flint); *Eo* means dawn, *Paleo* means early, and *Neo* means new or in this sense latest. These are convenient divisions; and you can talk of the "Paleolithic" or you can Anglicize it and call it the Early Stone Age as you like. But remember that the difference between one age or culture and another is much more than a difference of stone tools: a revolution in climate or a revolution in way of living lies between each of them.

But what exactly do we mean, in talking of our species, by cultures? Writers of anthropology and pre-history will use other such phrases too: they will speak of a social tradition, or of man being a social animal and having a spiritual environment.

These are difficult phrases to understand. But it is very necessary that we should try to do so before we go sweeping through the hard facts of history: such an understanding is a tool we use ourselves. The next few paragraphs may help.

Remember that very soon in their history early men must have learnt to talk. Nobody knows how: one suggestion is the rather startling one that imitative and expressive actions would be accompanied by expressive mouthings—"making faces" if you like—and that these, as it were by accident or perhaps rather in the intense effort to make oneself understood, became articulate. But however it was, do not belittle the achievement. It is a tremendous evolutionary step. It is the highest manifestation of the difference between beast and man, of the latter's superior brain. There is all the difference in the world between making inarticulate cries denoting danger, anger, fear, love, even solicitude, and inventing and using *words*.

For a word, even for the most concrete and material thing, means more than that one particular thing. *Banana* does not mean one particular banana, but *any* banana, the *idea* of banana.

Ideas have come into the world, the power to think and reason in the abstract. *Teaching* has come into the world too, teaching by precept and not merely by example: not just "imitate me!" but "let me explain what you should do and why you should do it if so-and-so should happen!" This means that the human child needs a much longer time in which to reach maturity. But he will be an altogether different creature from any beast when he has done it.

Possibly because of the gift of speech, possibly for other reasons, Man has always, so far as we know, been a social animal. That is to say he has lived together in groups, of the family or the clan or the tribe. And if you live together, and talk and teach and bandy ideas about, surely you do achieve a Social Tradition. You can call much of it ignorant Old Wives' Tales if you like, but of course it is much more. An insect has instinct, a mammal mother teaches its young by example; the human animal grows up in a society where there is a whole network of tradition, of what-to-be-proud-of-in-the-clan's-past, of what is right or wrong, particularly of what is and is not *done*—you know that word, "taboo". In fact, then, a social tradition, a social heritage, grows up. And this is the further point: however foolish those ideas and traditions and taboos may seem to a later civilization, yet if they *fit* the tribe or clan, if they seem right to it, if they help the tribe to live together and to thrive, then they are a *good environment*. Environment is the word. It is not a natural environment but a *spiritual* environment; and it is just as real and important. If you forcibly and suddenly destroy it, or if it grows too out-of-date and too out-of-line with the tribe's real urges and desires and material surroundings, then that tribe will wilt and die, just as surely as penguins would die if transferred to the Sahara or as a fish dies out of water.

Finally, the word "culture". It has by now almost explained itself. It covers all that is meant by a community's way of living, both spiritual and material: its tools and gear, its traditions and rules, its beliefs and ideas.

. . . . .

The sub-men who used Eoliths had not progressed very far: just one step further then stone-throwing in fact, a sharpened stone as a tool of all sorts, cutter, jabber, scraper, digger. Indeed, Nature must have seemed terrifyingly inimical to those embryo men; it is hard for us to realize how unfriendly.

And added to this, the Earth by some curious chance was going through a period of catastrophic changes. This is the period of the great ice ages, when slowly through the centuries ice caps and glaciers swung south and then north again, reaching in this country as far south as the Thames Valley and then swinging back to give place to torrential rains and even near-tropical climates—tigers and hippopotami in Norfolk. It probably conditioned the human race to hardihood, and stimulated it to invention; but it cannot have been pleasant. Man learnt to live in caves, sometimes ousting other animals before he could be sure of his home. He made, too, that great step forward: not to be afraid of *fire*, but to control it and use its heat.

Man had, by the time the last great ice age swung back, a better weapon, the "Paleolithic hand axe". Ugly and dangerous-looking, yet beautifully tapered at one end and rounded at the other to fit a big and powerfully gripping hand, it was used by Neanderthal Man (so called from being first discovered in the German village—or *thal*, pronounced tahl, of Neander). We moderns may have the blood of Neanderthal Man in our veins, though most probably not; he was near to true man or Homo Sapiens, but not quite there, with huge eye ridges, receding chin, and a stooping, slouching gait. Homo Sapiens came and ousted him from his cave and his hunting ground round about thirty thousand years ago. (Remember 30,000: it is a long time ago, but even so we have already passed some nine-tenths of our period: we are out of *geological* time.)

And now comes a time of plenty for the human race. The Earth's convulsions of climate are ceasing. The new race of Man is spreading. Particularly in the temperate North it is thriving, for the ice has left behind huge tracts of grass land, of tundra and steppe. On that the reindeer and the wild horse and the bison proliferate; on them Man feeds, and proliferates too.

Man is now a hunter, and a food gatherer. He is, you will note, a food gatherer, as opposed to a food producer, which comes later. He is learning to live on Nature, but he has not yet begun to control Nature.

Nevertheless he is learning and inventing. He certainly knows the habits of the animals he hunts; that must have been veritably burnt into his mind. He understands the seasons and the significance of the seasons; he has learnt, no doubt by very bitter experience at times, what is good to eat and what is not. His stone implements are becoming much more varied and specialized; he is even making tools for making tools. The first specialists appear: the flint miners and makers. Other materials are being conquered, wood and bone. The bow-and-arrow has been invented; that is the first machine, storing up the slowly exerted power of the human muscle into one concentrated quick release.

But now Ecology takes something of a sinister hand in the game, at least in the land of steppe and tundra. For the natural process in these latitudes is to develop into forest; and so develop they did.

Forest is not so easy a hunting ground; game is not so plentiful nor so big. Men's environment has changed, and they have to do something about it. This period is called the Mesolithic or Middle Stone Age, a poverty-stricken age. Men live by the side of rivers or meres; they fish and snare wild-fowl, they fell trees and invent a stone axe to do it with, they tame the first of the domestic animals, the dog.

A revolution not of weather but of man's methods divides Mesolithic from Neolithic culture.

For convenience of giving it a name we are still speaking in terms of stone implements: Neolithic men, by and large, *polished* their flint tools to a point or edge instead of chipping them. But that is almost by the way. That really great change is coming without which mankind could never have become civilized. The change is from food gatherer to food *producer*.

If you are a mere skirmisher on the edges of the great herds of wild beasts, killing and trapping the laggards and unwary ones, you will have about as much control over that herd as a gnat has over the human body it stings. You will, no doubt, do your best to attain it by the exercise of magical rights. (More about those in the chapter on Anthropology.) But there are other more practical ways, for instance by rearing the orphan animal whose mother you have killed. The practical ways were the more successful. Very gradually, men changed from hunters to herdsmen, to breeding and tending instead of merely killing the cow, the horse, the sheep, the goat and the pig.

Man is the hunter, and woman the home-maker. Perhaps, then, it was a woman who first realized what happened when you scattered the seed of wild wheat, and wild barley, that if you forewent the immediate pleasure of eating, and instead let the magical earth increase your grain "some ten, some twenty, some a hundredfold", you were a good deal better off. That was the second great step: to become an agriculturist.

At this stage, Man it has been said changed from being a parasite on Nature to being an active partner. Another way to put it is to say that the change is from paleolithic *savagery* to neolithic *barbarism*. A barbarian is not a civilized being, but he is a good deal nearer to it than the primitive savage.

With agriculture and husbandry go a number of other inventions and improvements. You need ploughshares and sickles. You need granaries and store-houses. You need pots for storing your grain and to cook in. Pottery is a clever invention, with a most complicated technique (ask any potter!); it also gives great opportunity for art and the creation of beauty.

And then somebody discovered what yeast could do to grain. It will do two things, as we have learnt in a preceding chapter: lighten or leaven bread by the carbon dioxide it gives off—and anyone who, as a boy scout, has eaten "damper" will know only too well the advantage of that—and will ferment and create all the delightful intoxicating drinks. That last may have its disadvantages, but the barbarian would have had a duller time without it, and this great release of inhibitions, stimulator of the imagination, is not to be discounted in the history of men.

The hide from the cow, wool from the sheep, fibre from flax; leatherwork, spinning, weaving, sewing: all those are coming into the Neolithic world. But let us look a little deeper than the mere recounting of material inventions. How is real progress towards civilization to be achieved and speeded up? The answer is, by the amassing of a *surplus* —a surplus of wealth or of mere food—by emancipation from the grinding cycle of merely attaining bare existence, of keeping body and soul together. Neolithic food producing could do this, up to a point. People were learning to store food at least for a season. But methods and implements were too primitive. True that men and women have learnt to settle down and live in villages; true that population has increased and Man is no longer a rare animal. But the village is too self-sufficient. There is no trade, little or no specialization in jobs. There is still a terrible dependence on Nature: drought and a bad harvest, and starvation and death stare you in the face. The margin is too narrow. Then again, primitive ignorant methods soon exhaust the soil. Land-hunger develops. Robbery, raiding, inter-tribal war must now have come into the world; there may never have been a "Golden Age of Innocence" which many an early historian has dreamt of, but when men only fought and killed the wild animals at least they may have been a good deal nearer such an age. If Man has become a partner with Nature, he is as yet a very poor and insignificant partner. How is he to break away; where will he find the key of emancipation from this grinding dependence?

The answer is, in one word, *metal.*

The Bronze Age arrives. It would be more accurate to say, first a copper age and then a bronze age, for bronze is an alloy of copper and tin and was a later discovery.

Now to speak of metal as being the next great revolutionary discovery is a good generalization, but it is something of an over-simplification. There were other changes and discoveries, interlocking and contributory to one another. This marvellous thing metal, which can be fused and cast and forged, which becomes liquid under sufficient heat and yet sets as hard as stone and with a cutting edge as good as flint, which does not easily break, but if it does can be remelted and recast—this wonderful stuff needs skilled specialists to handle it and presupposes a community of some leisure before its potentialities are realized. In other words, we come back to our idea of the need for a *surplus* above mere subsistence before progress can be achieved.

Easy food producing was what was wanted. It was there to be had in the sub-tropical river valleys : the Tigris and Euphrates, the Nile, the Indus. We are coming to the first civilizations of Mesopotamia, Egypt and India. We have come to the fifth millenium B.C. ; we have come to the threshold of real, of literate or written, history.

There is a new implication here which we must appreciate before we go any further.

So far we have spoken as if all the world were progressing towards civilization at the same rate. That is not true. But at least it is sufficiently near the truth to say that there has been so far no need to differentiate between one set of people and another, because those who were progressing were doing so—and the parallel is often amazingly close—on similar lines. In neolithic times some parts of the Earth were of course still in the stage of paleolithic savagery—for that matter in just a few places they still are. But the vanguard of progress was everywhere a similar vanguard. From now on, however, we shall have to distinguish between one community and another, sometimes between one race and another. There are still remarkable parallels: it is significant and permissible as well as useful to talk of the "bronze age culture" and the "iron age culture". But we shall also talk of Egypt and Sumeria and Babylon, of Cretan and Assyrian, Phoenician and Greek, of the Semitic race and the Aryan race.

This is the first time we have mentioned race. There is a whole Science of Race (Ethnology) and at the same time a whole lot of nonsense talked about it. The great thing to remember and realize is that race must *originally* have been a matter of environment. If a man is going to live in the tropics he will thrive naturally only if he develops a dark and sun-resisting skin. And so forth. The other things to realize are, first, that language and race do not of necessity run parallel, and secondly, that in any case the original races of the world have by now become so inextricably mixed that to try to disentangle them is almost impossible and to deduce arguments from so-called racial characteristics is highly dangerous. Ethnology can be a fascinating study. Ethnologists, confusingly disagreeing amongst themselves, will talk of Alpine races and Mediterranean races and Iberian races; will divide peoples into long-headed (i.e. looking from above), and broad-headed, and give these the long Greek names of *dolichocephalic* and *brachycephalic*. But perhaps it is better for the unexpert to say that at any rate there are three sorts of people, with black skins and crinkly hair, with yellow skins and straight hair, and with white skins and wavy hair. Perhaps we can go a little further and say that there is an intermediate people, definitely not negroid or mongolian, yet darker than the fair Nordics: a "dark-white" people, usually short in stature, who for as far back as we can go have inhabited the Mediterranean area. *These*, by and large, are the builders of the first civilizations, which we are now to review.

We come back to those fertile river valleys, and to the semi-barbaric, bronze-age first civilizations that grew up within them.

How things grew in those valleys, those Gardens of Eden! Living was easy. There was time to think—and chances too to grow rich and powerful, at the expense of your fellows.

Yet there was not everything in those valleys. Indeed there was little but fertile river-mud and clay. True, you made bricks from your clay, and so began to build more than mere mud huts: walls and palaces and temples. But you wanted wood for your building and you certainly needed those tools and weapons of bronze. That sort of thing came from the mountains. And you could afford them.

In other words we now get very much more specialization, men doing different jobs and depending on each other for their livelihood. We come, too, to *trade*. No longer is man a mere tiller and scratcher of the soil or a tender of animals; no longer is there one dead level of peasantry. The merchant has arrived; so too has the craftsman.

There is arriving with them—and sending something of a sinister shadow before them—the primitive priest and the primitive king. It would be better to call the latter the King-God. That was what he was. That was what he held himself to be. In the chapter on Anthropology we shall try to throw some light on the very queer workings of the early human mind. But here we are trying to stick to facts and material things.

The material things about the King-God were that he ruled the first *cities* (which were nevertheless really nothing more than his own personal estate and household), that the priest was his servant—his Civil Servant—and that in the management of these estates *writing* was invented. There arrives next in fact the clerk. You might say the first clerk and the first priest were the same thing—or rather that anyone who started as a clerk had every hope and intention of becoming a priest as well.

In Mesopotamia (Sumerian is the name for these first civilizations there) writing with cut reed-ends on thin clay tiles (wedge-shaped or cuneiform) was invented; in Egypt, writing on papyrus (*hieroglyph* or priest-writing). Most of us have a fairly good idea of how writing was evolved. You might almost say that in essence it first depended on the *pun*. It begins as pure picture. You want to draw a picture of a bee, and so you draw a picture of a bee. But then there is the verb to "be"; there is the syllable "be" in many words, "*be*lief" for instance. (We are of course drawing a modern analogy.) Why not draw a bee in those cases too—and for that matter a leaf for the second syllable of "belief"? You will soon go further, and to save yourself and everybody trouble, your picture of a bee will be "stylized", simplified into a few strokes which everybody learns to recognize but which in the end will have very little resemblance to the insect you first began to draw. Later in the story—and this in fact comes several centuries later, with the Phoenicians—your greatly stylized pictures will not represent syllables, but single letters of an alphabet.

Writing had tremendous significance. It gave *power*. The earliest writing was often on clay seals. The great man put his seal on his merchandise or on his documents—and it was as good as if he were there all the while to guard his merchandise or give you his orders! It must have seemed magical—there is evidence that it did seem magical. Its potency even continued after his death! Writing indeed extended a man's power both in time and space. The King wrote his orders and they were conveyed to the very borders of his domain. His domain could be larger. . . .

The Bronze Age lasted for roughly two thousand years. The Stone Ages had, of course, lasted longer. But, now that we are speaking of something at least comparable with our own civilization, it is really rather amazing to think that a culture, a way of living, lasted so long. There were great fluctuations, of course, advances and retrogressions, prosperity and then "Dark Ages"; but throughout a space of time as long as between the birth of Christ and ourselves much the same life was being lived, the same weapons, the same tools being used, the same arts practised, the same superstitions and beliefs observed.

Why was this? We can get some idea if we look at some of the Bronze Age improvements and inventions, the new "artificial environment" which was created, and then see how it was used.

Trade brought *ships*. Anyone who knows anything about ships knows how many clever ideas are embodied there—and the landlubber knows the same thing in a negative way by reason of all the technicalities of which he is immeasurably ignorant. The ships first sailed the wide rivers, hugged the coast of that inland sea, the Mediterranean, but then became more adventurous and crossed it and even went outside to the oceans beyond.

The horse was tamed, and bred to speed. The spoked wheel was invented, and so the fast chariot.

Money was evolved: something that gave a *standard of value*, that enabled you to exchange anything for anything else and not merely something you wanted if only you had what the other fellow wanted.

Studies were made in astronomy and in pure mathematics. Music and musical instruments, both wind and strings, were invented.

And all the while, as the name of the age implies, there was the metal, bronze, for weapons and tools.

But all this was for the benefit of the Big Man, the potentate, the King-God great or small: for him and his estate, whether it was a glorified village or an empire. The whole thing was a closed shop, it was a monopoly. Bronze was scarce, and that suited the monopolist; surveyors and accountants did their calculations the old laborious way of half a thousand years ago, and that didn't worry the monopolists, for labour was cheap. It was cheap largely because the *slave-state* had arrived. And with the slave comes the slave-raider. Another name for those King-Gods might have been robber-baron—and, as someone has said, "robbery is the oldest labour-saving device".

As well as a slave society it was a class and caste society, with the priest of those days (no implied connection with the modern priest) at the top of the hierarchy. (The very word hierarchy comes from the Greek for priest.) The priest went on with his age-old rites and customs; he was authoritarian, ultra-conservative, and no doubt felt that he was the cement that bound the State together. And all the time, though much happened, really nothing happened. City-states combined, formed so-called empires, swelled, shrunk, disappeared. There were wars; there were revolts. But there was no progress. . . .

No doubt much of this was inevitable, even necessary. Indeed some say that civilization goes naturally in waves of "classical" followed by "romantic" periods—periods, that is to say, of consolidation and conservatism, followed by exciting periods of throwing tradition to the winds. But the Bronze Age civilizations undoubtedly stayed too long, and ran to seed. The course of civilization, like that of true love, does not run smooth. You have need to make some sacrifices if you wish to cease being a barbarian and to live in a city-state: the Sumerian and the Akkadian and the Babylonian and the Egyptian and the Indian paid a very heavy price indeed.

There is another aspect of the bronze age life—and indeed it extends into the Iron Age—which if it did not bring happiness did at least prevent complete stagnation: that is the *Nomad* or shepherd way of life.

The nomadic is a different way from the city way of life. It goes on during these two bronze age millenia concurrently with the settled river-valley civilizations. It is a rougher but perhaps a tougher way of life. You tend your flocks, and take them seasonally from pasture to pasture; and you don't settle down, and at times you rather envy the luxury of the city dweller.

You also do much of the city dweller's long-distance trade—you and your sea-brother the sailor. You deal in bronze weapons for instance. And while the King-God and the baron are so bound by tradition and rigid order that no progress is made, the nomad accumulates his weapons—and then falls on the effete civilization, "like a wolf on the fold".

That, very much simplified, is what was always happening throughout the bronze age and after. It is indeed possible to say, putting it a little differently, that the first civilizations often cut their own throats by supplying arms to the outside barbarian (who in turn became civilized and did the same thing).

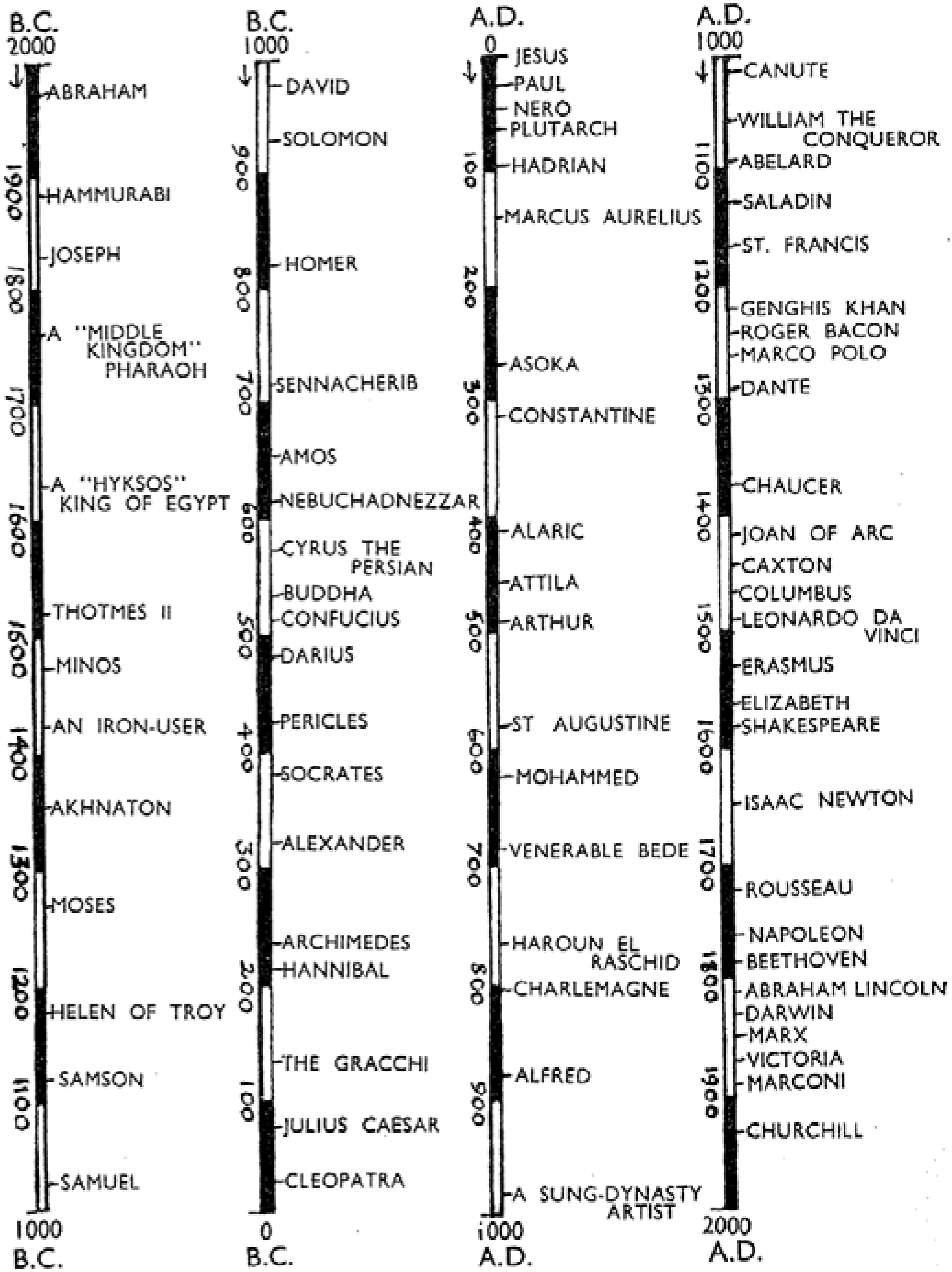
But apart from the nomads we must not fall into the error of thinking that in these years of history only the river-valleys counted. They were the core and origin. But there was the maritime type of civilization, of Crete for instance—from the archaeological evidence perhaps a happier and a less hidebound civilization. Dotted round the coast of the Eastern Mediterranean were other smaller communities, either more or less civilized but running on parallel lines: the Myceneans in Greece, where gold was prized, perhaps superstitiously prized, and where the megalomaniac kings built themselves colossal fortresses; the Trojans in Asia Minor, building city after city on the same site—waiting, one might say, for Helen and the undying fame that her story would bring to them.

Trade, too, extended from the Eastern Mediterranean, as far as Denmark, for amber, and to Great Britain for tin. And so nowadays, as we wander over the downs of England, we see the "long barrow", mausoleums of those bronze age chiefs or their hill fortresses, built in poor-relation mimicry of the pyramids and the great sacrificial burial pits and the stone forts of the civilizations of the Middle Sea.

Yet one more river-valley civilization there was, that blossomed forth somewhere about 1500 B.C. along the banks of the Yangtse in China. And finally, with which we can conveniently end this chapter,

THE HIGHWAY OF HISTORY

Some personalities of the last 4,000 years and their place (sometimes approximate) in time.



there were the Bronze Age cultures of Central and South America, the Aztecs of Mexico and the Incas of Peru.

They end the chapter aptly enough, because they point something of a moral. They lingered on unmolested, those two primitive civilizations, until the sixteenth century of our own Era, when they were discovered by the Spanish Conquistadores under Cortes and Pizarro. And even the stomachs of those tough conquerors must have turned at the ghastly and bloody religious rites which they discovered. It was a static culture run utterly to seed, steeped in cruelty and superstition. It needed another cruelty to cleanse it, the bright hard cruelty of iron and steel.

Books are at the end of the next chapter.

CHAPTER VII

THE HUMAN STORY CONTINUED

(History)

THIS chapter begins with the *Iron Age.*

There is of course no real break. But it is perhaps not an altogether fantastic generalization to say that we ourselves are still in the Iron Age; and so this second half of the story we may look upon as modern history as opposed to early or pre-history.

Iron is a much commoner element in the Earth's crust than copper or tin, but more difficult to smelt and cast or forge. Somewhere in the Armenian mountains, north of the Mesopotamian river valleys and south of the Black Sea, an Aryan tribe seem first to have used it. Presents of iron were sent to the great Pharaoh. But some little time later, in the fourteenth century B.C., when a Pharaoh writes to the Hittite King who has temporarily conquered these Aryans, asking for a supply of iron, the Hittite replies politely to his "brother" of Egypt but puts him off firmly with excuses. . . .

There is a great deal of significance in that. It is the Aryan barbarians who are going to develop iron, and not the tradition-bound, priest-and-king-ridden, Bronze Age, oriental civilizations.

Who are these Aryans? We say that now there is no such thing as an Aryan race, but only many offshoots of an Aryan language. Once upon a time, the two, race and language, did go together: a Nordic tribe, fair and blue-eyed we imagine, peopling the steppes and forest lands of North and Central Europe. They obviously did not suddenly appear on the face of the Earth; but they do appear suddenly in history. While those first urban civilizations of the Near East were going through their two thousand years of such slow change, entirely ignorant of what was going on without, the Aryans, sparse but increasing, were living in hide tents or primitive temporary huts, taking a "snatch crop" and moving on. They impinged on the old Bronze Age civilization most effectively by penetrating down the Balkan Peninsula.

They were barbarians who could learn; nevertheless they were barbarians. They brought with them a new Dark Age. There is a real break in history: the records for a time stop; misery and slaughter stalk the land.

But there *is* continuity. The Aryans must have found much that they disliked, despised, or simply did not understand in an oriental King-God's court. But they understood the useful and clever things which the craftsmen and the scholars of that court practised or produced.

What qualities or assets had the new people which the old people did not have? They had no doubt a new virility. But we must not stress that too far. They had—or were soon to have—three things: iron; a proper alphabet; *coined* money. All three were *democratizing* forces.

That needs some explanation. We have said that scarce bronze was the nobleman's monopoly. That could never happen with iron. To quote from a book which we shall be listing at the end of this chapter, *What Happened in History*:

> "Any peasant could afford an iron axe to clear fresh land for himself and iron ploughshares wherewith to break up strong ground. The common artizan could own a kit of metal tools that made him independent of the households of kings, gods, or nobles. With iron weapons a commoner could meet on equal terms the Bronze Age knight. With them, too, poor and backward barbarians could challenge the armies of civilized states whose monopoly of bronze armaments had made them seem invulnerable."

There is the same trend with the alphabet and with coined money, though these are things that the Aryans inherited and developed rather than invented. It is comparatively easy for anyone to learn to read and write with a proper alphabet such as we use ourselves; whereas the old pictograph method of the early civilization is an expert's job, almost a life's work to learn fully and properly, as written Chinese is today.

It is surprising perhaps to think that coined money should make much difference. But before its invention (by, tradition has it, the fabulous King Croesus of Lydia), to use money meant either to weigh out laboriously your gold and silver or at best to have it in bars, stamped with the King's seal. Of what good was that to the *little man*, to the small peasant farmer with his diminutive surplus product to dispose of after the harvest? But with "small change" the position was very different. The peasant could save; his money gave him *effective demand* for the products of his fellow men, and the townsman and the craftsman. The wheels of trade and exchange are lubricated. And so the monopoly of the Great Household, the King-God household of the Bronze Age—monopoly in ideas, in learning and wisdom and science and craftsmanship and trade and the graces and luxuries of life—has gone, or at any rate is going.

And with it largely will go black superstition, and hidebound unquestioning ritual, and the belief in magic and appeasement and sacrifice, and the cult of the dead. Largely, but certainly not entirely. The Iron Age may have been introduced by an ill wind that brought another and a greater Dark Age. But it was certainly something of a clean wind too.

Who in cold fact were these heroic Iron Age Aryans, and what in history do they call themselves? They call themselves the Scythians and the Phrygians; the Medes and the Persians; finally, the Greeks and the Romans. They descended on Mesopotamia, that land already ancient in war and empires, and played the games of war and empire better than anyone had played it before. (The Bible tells the story.) Darius the Persian even absorbed Egypt. In this process it is not altogether untrue to say that the Persians became half orientalized themselves—so much so that when the Greeks in the fourth century B.C. successfully ward off absorption by the Persians it seems almost a pure success for the Aryan, the new and wider and more intelligent way of life, against the old ways of Eastern despotism.

We come, then, to the Greeks. And we come to them almost with awe: they mean so much in history.

They start cheerfully and crudely enough. The early Greeks—they called themselves Achaean—were, quite simply, swashbucklers.

The Age of the Divine Monarch has gone. In his place appears the Hero. He is the warrior, the leader. But he is not worshipped. At death his body is burnt, with pomp but with relative simplicity and without human sacrifice. The pyramid and its imitation the long barrow have given place in the Iron Age world to the chieftain's funeral pyre, and the round barrow—the more common, Celtic round barrow of our English Downs.

Homer has described for all time the life of those early Greek Heroes, Agamemnon and Achilles and the clever Ulysses, who sacked Troy in revenge for a seduced Helen and then wandered the Mediterranean, which seemed to them, and to us in the telling, a vast and terrifying ocean. They drank, they sang, they quarrelled, those *heroic age* warriors; like the Saxons after them, they sat in their great windy halls and listened to the tales of great deeds.

The epics, the sagas, are invented. That is important. The story, poetry, *literature*, has at last come into the world. The written word has become more than the prescript of power, the King-God's seal, or his scribe's account book; it has become the vehicle of thought and emotion.

Gradually, in the first five centuries of the thousand years before Christ, the Greeks became civilized. And how they progressed! Emancipated from superstition, they used the birthright of the species, their brains and their imaginations, to magnificent effect.

It is hardly an exaggeration to describe the sudden flowering of the Greek civilization in the fifth and fourth centuries B.C. as the outstanding event of all mankind's history. Art flourished; science flourished. Architecture, sculpture, drama: all were emancipated from a debilitating subservience to magic and superstition and depotism. Aristotle is the great name in Greek science, though there are many others. Let us, these men said in effect, examine Nature and the natural universe, and try to understand it!

But there are other sciences than natural sciences. There is the science of how one should be governed. It is not for nothing that our words here—democracy, oligarchy, plutocracy, tyranny—are all Greek words. The idea that man might govern himself was coming into the world. There is Philosophy. There is logic, and the business of how to think straight and argue straight. Socrates and Plato are the great names: Socrates the ugly, hardy little man, who wandered round the streets and market place of ancient Athens, and asked *Why?* and questioned everything; Plato, his disciple, who put his master's teachings and his own thoughts into writing; who wrote the first Utopia, on how Man might dare to plan a perfect State. . . .

After Greece, Rome. In passing from one to the other we must say something in explanation of why Greece declined.

There is no simple answer, and any short explanation will be an oversimplification. Perhaps the fact that Greece, like all the civilizations before it, was a slave-state has some bearing. We come back to the idea we have touched on before: there is lack of practical incentive. Greek science is largely hypothetical science; *invention* was not there, at least not practical invention. And so, hard economics take hold of the situation. Greece was not a self-supporting country, people were not producing enough food and other essentials. There is the political angle too. We have spoken in another chapter of Greece's geography shaping her into almost infinitesimal city-states. And those would *not* combine.

Perhaps her glory and her splendid vitality were mixed up with this narrow fierce patriotism and rivalry; perhaps it could not have been otherwise. By only the narrowest margin did the Greek states combine sufficiently to ward off Persia. A century later—let us have an exact date, 338 B.C.—she fell to Philip of Macedon, father of Alexander the Great. Alexander spread Greek culture over the world—and more or less killed Greece in the process.

It is true to say that Rome is the heir to Greece. In the realm of ideas and culture one might say that she was no more than the generally efficient but sometimes unintelligent disciple. We speak of the Biblical Mary and Martha, the thoughtful one and the one who did the chores; in the story of civilization you might call Greece the Mary and Rome the Martha. By comparison the Romans seem a less imaginative but more practical people.

With the rise of Rome there came up for final decision the struggle in the Mediterranean between what we may call variously the old and the new civilizations, the Semites and the Aryans, the Orientals and the Europeans. Rome fought to the death with the Phoenician Empire of Carthage, and won. Exit the old.

But we are in danger perhaps of finally dismissing those first civilizations without doing full justice to them. It is largely to the East that the world owes the whole of its religious thought, both good and bad. It is true that a great bar to progress was the preoccupation of the old civilizations with a tangle of superstitions, rituals and magic observances. But if we turn back—as we must for a moment—to the sixth century B.C., we see another side to the picture.

This sixth century sees a great budding forth of teachers, moralists, sages, prophets, and founders of religion. In China there is Confucius and Lao Tse, in India Gautama Buddha, in Persia—the Aryan influence here—Zoroaster, in Palestine Isaiah and Amos and Hosea and the other Prophets of the Old Testament.

All broke away from that cruel, hard, impersonal utilitarian pseudo-religion of the God one could bribe and propitiate if one were drastic enough in one's observances. All turned to the idea of personal conduct, to the relationship between God and the *individual*, to ideas of justice and personal morality and right conduct. It was all a great step forward for the spirit of man. In particular, the Jewish prophets can be said to have created in the process the first national *literature* and through it the first national consciousness. They paved the way for Jesus and the Christian Church: which brings the story back to Rome, since Rome and the early Christian Church became quite inextricably interwoven.

The story of the Romans covers a long stretch of time. While

Athens blazed forth with brilliance Rome existed and grew and built up her strength for her great struggle; she was then a simple and healthy republic. Perhaps at the time of her defeat of Carthage she was at her greatest; perhaps she so exhausted herself by that struggle that she never recovered from it. Nevertheless her real fall and the coming of the Dark Ages was nearly seven centuries ahead. Rome grew rich: a slave state and a slave empire, exacting tribute. Her economy was unsound; and like Greece, and for very much the same reasons, she declined—the seeds of decay already in her.

And yet from Julius Caesar to A.D. 455, when the Vandals sacked the City, Rome maintained a great empire, a great civilization and a great peace, the *Pax Romana*. However sickening is much of her history, however blotted with intrigue and cruelty and reddened with massacre and murder, Western civilization owes her an enormous debt. Western civilization is in fact her child. There is a reason why our schools teach and have always taught Greek and Roman history: *we cannot understand ourselves and our traditions without them.*

Laws and roads: those are the two things that Rome is usually said to have given us—a peculiarly inadequate remark. To say, rather, administration might be more helpful.

Rome really did teach the world a great deal about how to govern itself. The words we use gives us a clue: republic, senate, consul, prefect, judge. The Romans ruled and ran an Empire efficiently. And you cannot do that without good roads and good laws.

But there is a wider significance to all this. For the first time a great number of people moved freely and peaceably about a large area of the Earth's surface: the merchant, the trader, the administrator, the garrison soldier. With the man travels his mind—and in the process of travelling he widens both his own mind and other people's. Ideas were fertilized. Culture—Greek culture fundamentally—spread. There spread material signs of that culture too: the villa, the farm, the beautiful city, the magnificent building. The Romans were great builders, and great architects.

And yet we have to come back to that moral and material decay. The efficiency did not last. And something further: even with the efficiency was there happiness on the part of the common man?

It seems fairly obvious that there was not. The time was ripe for another uprush of religious feeling, for a struggle for decency and morality and happiness—if not happiness in this world, at least under God in a world to come. Christ and Christianity came to the world.

It has been said that Rome started by persecuting Christianity and ended by needing it. That is true. It needed it as a prop, and used it. Almost, one might say, the Christian Church took over the tottering

Roman Empire. The Church survived, and Rome succumbed—to the Barbarian.

We come back to that idea of the hardy nomad inundating at intervals the effete urban civilization.

But this time it is not quite so simple. There is as it were a double push. The explanation brings back China into the picture.

Quite obviously, history does not stop anywhere at any time; things go on happening. All we can do is to try to trace the revealing trend, to treat of those parts where the happenings are most significant, at any rate to a Westerner. Hence our only occasional reference to China and what we call now the Far East. Indeed it must be growing apparent to the reader that as we advance towards the present time it becomes increasingly hard to generalize, to give a clear short story. Soon, in this effort to make a sketch of the whole history of the race of Man, we shall be reduced to putting down the barest and baldest statements, a sentence attempting to cover a packed century, and to leave it at that.

China in the two centuries before Christ was, says H. G. Wells in his *Short History of the World*, "the greatest, best organized and most civilized political system in the world. It was superior in area and population to the Roman Empire at its zenith. It was possible then for these two vast systems to flourish in the same world at the same time in almost complete ignorance of each other."

Yet China, the China of this time, of the Han dynasty, did influence Rome indirectly.

To the North of both empires lay the vast areas—forest and steppe and desert—of Europe and Northern Asia. In the Western part, roughly speaking, were uncivilized Aryans, Goths and Vandals and the like; in the Eastern part were the uncivilized and nomadic Mongols or Huns. Both pressed continuously and, perhaps owing to climatic changes that did not suit them, increasingly on to the lands to the South of them. China kept out the Huns with the help of the Great Wall. The Huns partly found an outlet into India, and partly pressed their barbarian Western neighbours, who *in turn* pressed the Roman Empire: if China had been less strong Rome might have been less troubled by Vandal and Frank and Goth.

Then, somewhere about A.D. 160 to 180, came a great Plague to scourge the civilized world. (These scourges—there is to come another major one twelve hundred years later—are, just as the climatic changes and the ensuing waves of nomads across the face of the Earth, major events in history when we view it high and wide: Man is still an animal largely at the mercy of his environment.) The Plague affected Rome more than China, because she was already weakening and decadent. The long tragedy of her final decline was under way. The barbarians could no longer be held at the outposts. Emperor after Emperor struggled to hold off the inevitable, to hold together what was doomed to disintegration. Claimant and pretender fought each other for the imperial throne. The Empire split into two, East and West, with one Emperor at Rome and another at Constantinople (the ancient Byzantium). The Emperors became puppets of the Barbarians, or were of Barbarian blood themselves.

And in the fifth century A.D. the Huns ceased to take a secondary and took a primary role. Attila, "the Scourge of God", has a name which has resounded through history as the epitome of power and terror and brutality. Under him the Huns penetrated right down to Northern Italy and to what is now France. At the battle of Châlons in 451 Attila was defeated; in 453 he died: the Mongolian hordes retired—for eight hundred years.

With the fall of the Roman Empire we must make a break in the story; it is indeed itself a very real break in history. We must make a break in our method too. To generalize and condense and at the same time to remain reasonably accurate is becoming impossible. We have only fifteen centuries left—fifty generations of men, let us say: only a fifth of man's civilized story, a twentieth perhaps of True Man's story, a five-hundredth of the time since men arrived on the scene. And yet how packed that time is with incident and change! We know so much about it; it covers for some of us nearly the whole period about which we have learnt any history at all.

This sketch of history is in a way an effort to cure the harm done by that one-sided approach. The reason for such an approach has been partly no doubt because it is only comparatively recently that we have come to know of those earlier times at all, and so have not yet fully developed the habit of thinking in terms of them. It is partly, too, that the later times are so much better documented: we can know exactly what people thought and said and wrote, because so much written record remains for us. And so, quite rightly, we do learn mostly about the last dozen centuries or so. It is tremendously interesting. But it is only truly understandable, we can only hope to draw the right lessons from it, *it will only begin to be in focus*, if we have beforehand absorbed an idea of the whole scale of mankind's history taken as the story of a species and as a continuation of the whole story of life on this Earth.

We come then to the centuries which we all know most about. And we propose first to set down a few curt, even cryptic, headings, and then to explain them very shortly. That perhaps will help to retain the wide, the bird's-eye view to the end.

Here they are then, the major events and trends after the fall of the Roman Empire:

Dark Ages
Feudalism
Mohammed
Genghis Khan
Renaissance
Reformation
Atlantic
Nations
French Revolution
Industrial and Scientific Revolution
One World.

The Dark Ages of our own Era—as we have said there had been times before when all progress seemed to stop, and all that men could do was to hold on precariously to part of the previous gain—these Ages last, very roughly, from the fifth to the twelfth centuries. The Christian Church does much to keep the lamps of learning and culture alight. It has to form itself into a tight organization to do it—something much more and in many ways much less than the direct simplicity of its founder. And do not forget that the Roman Empire, and its successors the Catholic and the Greek Orthodox Churches, was split into two, with their centres at Rome and Byzantium (Constantinople). The Byzantine Church and Empire has had an influence on art and ideas in Eastern and South-Eastern Europe very different from the Western influence.

With the collapse of the *Pax Romana*, Western civilization had broken up largely into the warring of petty princelings, dukes, piratical and robber barons. The Mediterranean becomes unsafe; the Roman roads become unsafe. The Roman villa is gutted, the Roman town—from Britain to the Balkans, from the Rhine to the Lybian desert—is left to the wolf and the jackal and the hooting owl. Feudalism slowly arises as the best method in the circumstances of preserving human society. The slave becomes a serf. He is tied to the land, but at least for much of his time he is free to work for himself. There is a ladder of allegiance, up to the prince or baron himself, an agreement to fight for the chief in return for rights to live on and work the land. At least it gets rid of the Greek and Roman slave-factory, and the bad economics of ill-paid labour. Something better can grow out of it—and does, slowly and painfully, in the Guilds and by way of peasants' revolts.

But things happen in these long centuries.

Mohammed was born A.D. 570 and died A.D. 632. He brought the

Arabian desert into the world picture, the Semites back into it. He dragged his fellow countrymen out of primitive idolatory and brought forth both their latent powers and their latent ferocity. The Arabs—or Moors or Saracens as they were variously called—had within a century spread their rule and religion and culture from Spain to the borders of China. Though they spread it at the point of the sword, they brought a new draught of life to architecture and literature, to mathematics and that queer, half-ridiculous forerunner of chemistry, alchemy. Islam remains a power in the world, but for only a century or two did the Caliphs of Baghdad shine with spectacular brilliance.

And in the process they made Western culture, product of Greece and Rome and Catholic Church, more conscious of itself as "Christendom".

A few more generations, and the Mongols again burst forth into the pages of history—under the generalship of the great Khans, *Genghis Khan* and Kubla Khan and the rest. In the middle of the fourteenth century Baghdad falls to them. China this time falls to them; India falls again, half Russia and Poland; and then again the tide is spent. As an offshoot and extension of all this, another Tartar people, the Turks, rise to power and form an empire around the Eastern half of the Mediterranean which lasts into the beginning of our own century and creates a name for itself as perhaps the most deadening rule in history.

Nevertheless it is still that same Mediterranean that remains for a little while yet the focus of interest and which first shows the real signs of revival. The Renaissance has already started, in the city-states of Italy, Venice and Genoa and Florence. Those are reminiscent of the early Greek cities; but they are even richer.

The Renaissance, the "Rebirth" of knowledge and learning and vitality and the spirit of adventure and enquiry, spreads. Traditionally, the fall of Constantinople to the Turks in 1453 and the expulsion or escape of the learned denizens of the Byzantine Court sets the process going. For those learned men had been the imprisoned caretakers of Greek literature, the Greek ability to think, philosophize and to ask *why?* But it would all probably have happened in any case: the time was ripe, the spirit of Man, fortunately, cannot be suppressed.

We cannot follow it. As we have said, it is not only learning that revives, it is vitality and adventure. Printing and the multiplication of books—a step forward connecting with, and wellnigh as important as, the inventions of speech and writing—help forward this reawakening of the spirit. We come to the discovery and opening up of the New World.

And with that discovery comes, inevitably, a far-reaching shift of great significance and importance. The shift is away from the Mediterranean to another and larger sea. Hence the cryptic heading above, *Atlantic.* The Atlantic becomes the sea of commerce and of rivalry, the Atlantic and the lands that surround it. England takes the important role. Later it will pass to the United States of America.

At the same time comes *the Reformation*: the ferment of ideas is breaking down the power, the temporal power at least, of the Roman Church. That Church, under the title of the Holy Roman Empire—by now, to repeat the old quip, neither Holy nor Roman nor an Empire—failed in the magnificent attempt to form a united world. The princelings and kings of Europe are becoming monarchs—Grand Monarchs. They are forming *Nations*; people—so recent is the idea—are ceasing to think of themselves as members of a city or a district and at the same time members of Christendom, and are beginning to think of themselves as Frenchmen and Englishmen—and, later, Germans and Italians and the rest.

Next the ferment of ideas attacks the political and the economic and the social structure: the *French Revolution.* The common man arises and demands Justice. Men wear the Phrygian cap of liberty and their minds go back to those Greeks who invented the word Democracy and those better, simpler Romans who made good laws. There are other revolutions within our last few generations, but the French Revolution is never likely to lose its significance or its influence upon great minds—from Abraham Lincoln with his Gettysburg speech to Franklin Roosevelt and his Four Freedoms.

From ideas to things. The greatest revolution of all is the *Industrial and Scientific Revolution.* In the last two hundred years or less we have learnt to manipulate our world, to control our environment, to understand, to invent and to make.

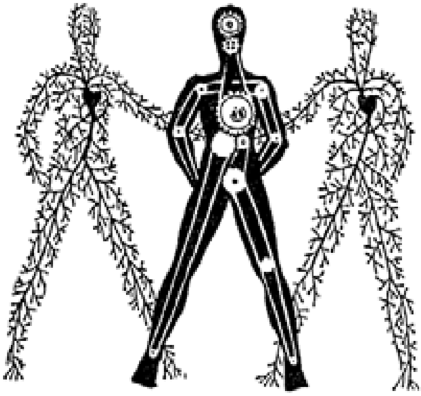
If we say that we are still in the Iron Age, then indeed the last two hundred years have shown that we are in it even more than ever. Or we might call the last generation or two the Steel Age, the Electric Age, the Power-Engine Age and so forth. The fact remains that all this has utterly changed the average man's way of life. The city dweller of today—the proletarian if you like—is more different in his way of life from the man of two hundred years ago than was that man different from his predecessor by two thousand years.

That needs thinking about. Man has changed the face of his world. Increasingly he creates an artificial environment for himself and increasingly he controls that environment.

He has also made his world *shrink.* He can now move about his world in days where before he took months. For two systems or Empires to exist in this world and know nothing of each other, as did the Chinese and Roman, is no longer even imaginable. We are all now *interdependent.* In fact we are now *One World*—that is the position that History has reached.

Upon how well and clearly we realize that may depend whether in future there is to be any world at all—or at any rate any human race upon it. . . .

BOOKS: In the writing of history as the consecutive story of Man's adventure H. G. Wells's name still stands first. He wrote a long book and a short book, *The Outline of History* (Cassell) and *A Short History of the World* respectively. The latter is in many cheap editions, including the *Pelican* Series. The former has recently (1951) been revised and brought up to date by Raymond Postgate. To these and to *What Happened in History*, by Gordon Childe (also published as a "Pelican"). these chapters owe very much. There is also *The Story of Mankind*, by Van Loom (Harrap), and *The Emergence of Man*, by Gerald Heard, the second a deeper book. Professor Breasted, Gilbert Murray, T. R. Glover, write of the ancient and classical world, and Elliott Smith very stimulatingly of the primitive world. If you want to see how ordinary people lived in the past, go to the "Everyday Things" series of books by Marjorie and C. H. B. Quennell (Batsford).



CHAPTER VIII

THE HUMAN BODY AT WORK

(Physiology)

THE shift is now from Man with a capital M to man with a small m, from Mankind in the mass to the individual or, rather, the average man. We have done with the story of the species and turn to look at the make-up of this species; if human history is a part of the story of evolution, then physiology is a part of biology. In biology we looked at vertebrates, and even had a glance at other kinds of bodies, lobsters and starfish and so forth. Now we have a look at the body of *Homo Sapiens*. It is a longer look—after all, it is *our* body.

Throughout this chapter, remember that biblical phrase that has become a cliché: "fearfully and wonderfully made". The inventor of that phrase had a flash of intuition; he wrote better than he knew. For science has lately shown us indeed how wonderfully fine, flexible, neat and ingenious is our bodily machinery.

Historically it is an extraordinary fact how late comes Man's knowledge of his own physical make-up. It was only in 1628 that William Harvey told the world that blood did not merely ebb and flow in our veins and arteries, but *circulated*. And even so the world was loth to believe him. We have all read somewhere of the apothecaries and leeches of the eighteenth century, those poor and sinister apologies for our modern doctors whose sole reactions to illness seemed to be so to bleed and purge the patient that he survived rather because he was tough than that he was benefited. Before this it was largely a matter of incantations and magic. The Greeks, as in so many things, showed a better understanding; they believed that the human body had rhythms and powers of its own and that illness could best be cured by giving the body the greatest chance possible to effect its own recovery—good advice, that, to some of our own generations, too prone to think in terms of operations and bottles of medicine, yet all the same a fundamentally negative outlook conditioned by what was really little more than a profound basic ignorance. The fact remains that for more than ninety-nine hundredths of his existence Man has known virtually nothing of how his body functioned.

There is all the more reason then for us to know something about the subject of Physiology, now that the knowledge is available. It all has its very practical aspect. There is too much in this world of sheer cruelty to our own body through not knowing the first thing about how it works. We believe old wives' tales; we dose ourselves with highly advertised and often completely inappropriate drugs; we clog and overload our body with the wrong, or too much, food; we put stresses on it, and fail to keep it in running repair, in a way that we should be ashamed to treat our motor-cars or our bicycles or our petrol lighters. In fact knowledge of our bodies, we might say, is a matter of common sense as well as of education.

It will be a very good idea first to think of our body as a machine. It will then be a good idea to forget that, and to see how much more than any man-made machine our body really is.

The machine analogy is, up to a point, remarkably close. For a machine is a converter of energy; it is a user of bottled-up energy, or fuel, in order to do work. And that is just what our body is, *with our food as the fuel*.

Some knowledge of physics and chemistry is going to be useful now. We learnt of the "conservation of energy", that you cannot just get energy out of nothing. Moreover, we learnt that energy can be obtained from the burning up of substances; and that the burning-up process cannot take place without the presence of that fundamentally important element, oxygen.

That brings us to our breathing or *respiratory system*. It is really much better to use those long words respiratory system than the simple breathing. They mean something more. And if we use the word breathing loosely we shall always think of drawing air through our mouth and into our lungs, and fail to understand that insects, who draw in air, as we have learnt, through tiny tubes all over the body, that frogs who breathe partly through the skin, and fishes who pass aerated water through their gills, are all performing this job of respiration.

A fire uses up oxygen, sends out carbon dioxide, and produces ash —or, in other words, changes the chemical substance of what is burnt.

In the process it produces heat, or energy. That is "combustion". Respiration does practically the same thing, but without flame. Respiration is indeed defined as "the breakdown of chemical substances in organisms with a release of energy"; that is what, in our particular case, breathing enables us to do.

Having as a preliminary grasped that idea about our breathing, we can set out the basic functions of the body regarded as a machine, coming back to something more about respiration in its turn. Our bodies must have:

1. A digestive system, to break down our food into much simpler chemical substances;
2. A respiratory system, to convert those simple substances, by the aid of oxygen, into energy;
3. A circulatory system (of the blood), to carry the dissolved food and the oxygen and the waste products where they are wanted;
4. A reproductive system: for growth, to make good bodily wear-and-tear, and to reproduce new life;
5. A nervous system, to enable us to respond to our environment, and to control our bodily functions and actions.

In the rest of this chapter we shall say something about these five —digressing no doubt occasionally.

Digestion: we must be sure that we have grasped the proper meaning of this. It is, the breaking down of food ready to be turned into energy.

Now the digestion of our food is a highly complicated process, mostly because the molecules of our food are themselves highly complicated—you remember that terrific chemical formula for an acid from animal fat. The food goes a long journey, rather like something on a conveyor belt, through room after room to have performed on it process after process. Here is the order: mouth, gullet, stomach, duodenum, small intestine, large intestine.

Partly the processes are mechanical: the obvious one of mastication by our teeth, and the less obvious ones, entirely beyond our voluntary control, of rhythmical movements forcing the food down our gullets and churning it up in our stomachs. That is a little crude, but very necessary; the even more important series of actions are chemical ones. We produce by our various organs digestive juices or *enzymes*, to act on our food in different ways and actually to break down the chemical composition into something much simpler.

The process even starts in our mouth, where we produce ptyalin in our saliva to help digest the starch in substances—that is why children are told not to gulp down their milk. But most of the enzymes are produced further along the route: in the stomach and duodenum themselves but also in the pancreas and liver and kidneys.

Now we cannot go into detail here—perhaps few of us want to—for it is too complicated. Our organs are often ingeniously arranged to do more than one job; they defy neat ticketing. But of two points we can and should be aware. The first is that, perhaps rather obviously, different kinds of food need different treatment. Fat, for instance, which takes longest of all to digest, needs not only enzymes but bile, which the liver produces, to *emulsify* it (or break it into the tiniest droplets). The second point is this, that the breaking-down process produces a number of waste products which would be definitely dangerous to our system if we did not get rid of them quickly. Meat, for instance, produces, when the enzymes get on to it, ammonia. Both the liver and kidneys get to work here. The liver changes the ammonia into urea and the kidneys get rid of the urea (and so help to prevent us from getting rheumatism). The kidneys are the great "expellers" of our body, and they are helped to do it by a continual trickle of water through them. (Drink a lot, the doctor often says.)

There is perhaps one implication to all this which we need to consider before we go on to the respiratory system. A slight knowledge of our rather frighteningly intricate digestive system may tend to make us hypochondriacs, "health-worriers". It should not do that: our body-machine is really amazingly tough and resilient. It should however make us treat that body with respect; if the glutton had to do, himself, the equivalent of half the work he demands of his poor body he would be a reformed character from tomorrow.

The Respiratory System, as defined a few paragraphs back, performs that operation of "breaking down chemical substances with a release of energy". The great point is that it needs oxygen to do the job.

Now it is in all the cells of our body, in our muscles and so forth, that there takes place the real job of converting our machine's fuel (food) into energy; and it is the blood—as we shall see in more detail shortly—which carries the oxygen where it is needed. We have got, then, to get the oxygen *into our blood*. How?

It is really in essence remarkably simple. Our blood contains a special constituent for absorbing oxygen. It is called *haemoglobin*, and is housed in what are called the red corpuscles ("little bodies") of the blood. It is one of those miracles of nature, one of those absolutely essential cogs in the wheel of life, such as is the chlorophyl of green plants (and with which significantly it has some similarity). With this marvellous substance there to help, all that is necessary is to get the blood of the body near to air (but damp air—remember the significance of water all through the evolutionary story); and by diffusion the oxygen is absorbed.

You will remember, too, that insects fortunately cannot grow very big. This is the reason: their method of *oxygenating* the blood is second-rate. We humans, on the other hand, have both a pumping mechanism and an intricate and labyrinthine system of air pockets, which we call our lungs. "If all the air pockets, or *alveoli*, of the lungs were laid out flat," says the science book, "they would occupy a surface of about a hundred square yards"—which is a very good reason for their not being flat.

And now we come to the blood. If ever there was a labour-saving device, if ever there was an ingenious arrangement for combining several functions to be performed by one medium, it is the blood. It does these things:

Carries the dissolved oxygen to all our cells and the waste product, carbon dioxide, back to our lungs for expulsion;

Carries round, also to all our cells, our food after our digestive organs have broken it down and simplified it so that the cells can use it or "burn it up" by the aid of that oxygen;

Carries to our lungs and our liver and kidneys, to be got rid of, the harmful products of our cells and digestive activities;

Carries round certain chemical regulators, or *hormones* (see later in this chapter);

Helps to keep our body at an even temperature, and protects it against disease.

We have just said something about the dissolving and carrying round of oxygen. Now the seeping of our digested *food* into the blood stream takes place in something of the same simple and direct way. It happens in our duodenum or small intestines. We cannot do better than quote *The Science of Life* for a short and succinct description:

> "The inside surface of the intestinal tube is given a velvety appearance by the presence of myriads of finger-like projections, the *villi*, each about a twenty-fifth of an inch long. But it is restless velvet; the villi wriggle about when a meal is being digested, lengthening, shortening, and swaying from side to side. It is through the villi that nutriment enters the blood. Each of these absorbent fingers is in contact outside with the digested food, while inside it passes a copious stream of blood. The cells of the villi are active, like the cells of the kidneys or the salivary glands. They lay hold of nutritive molecules in the gut and force them into the blood stream."

Thence these "nutritive molecules", the result of our eating and digesting, are carried through to the liver, which, doing another of its jobs and acting like a combined customs official and warehouseman, eradicates the undesirable and holds up what is wanted so that the blood can do its next job of carrying the finally prepared and purified fuel to the cells of the body.

What a job that is! In our Biology chapter we started with that "fundamental brick" of life, *the cell*; we now come back to it in describing the human body. There are something like a thousand billion—1,000,000,000,000,000—of them in our body, and the blood has to get to all of them. We all know that the blood pulses from our heart through our arteries and back more slowly through our veins. But in between comes the miracle: what are called the *capillaries*, or one might say microscopic veins, a wonderfully intricate, delicate system of vessels of the smallest diameter and the thinnest walls, reaching every part of our body. Here are figures once more to impress this upon you: the capillary vessels in a man's body put end to end to form a continuous tube would girdle the earth two and a half times; a single cubic centimetre of blood has by this method about ten thousand square centimetres of surface at which chemical interchange—the respiratory or burning-up process of food into energy—can take place.

Yet even so the cells of our body are so small and, as one might say, so knobbly and irregular in shape, that something else is needed to establish contact. This is *lymph*, which is formed by a seepage of clear fluid from the blood and which bathes all our cells and has a whole circulatory system of its own—a much more sluggish system incidentally, hence the word "lymphatic". Lymph is the stuff which forms in blisters and chilblains and bumps.

The waste-carrying activities of our blood we have covered sufficiently in what we have said of the liver and kidneys. Remember, however, that there is one other major process, that of carrying carbon-dioxide, the by-product of our fuel-burning, back to our lungs, and so out with our breath, thus completing the cycle of respiration.

There remain the blood's jobs of carrying round chemical messengers of regulating our body heat and helping to keep our body in health. Let us take those in turn. What happens when we get a fright?—When we are nearly run over, let us say, or even when for a moment we think we are going to get run over. Things happen very quickly, and it is all quite independent of any conscious control on our part. We jump out of the way; we go hot and cold all over, and we find that our heart is beating very hard indeed.

Physiologically, a message is sent by our nerves to one of our endocrine glands called the adrenal, which at once pumps the necessary chemical messengers or *hormones* into our blood. These flow round everywhere but have the desired effect *only* where they meet organs that respond to them. In this case it is the heart particularly: it pumps furiously. At the same time our digestive processes are checked and blood is drained away from them; the liver pumps stored fuel into the blood for our muscles to use, and, in fact, everything is done to enable us to make a supreme physical effort. At the same time—not always quite so necessary in a modern civilization—the sweat glands work overtime to cool the body, and our hair makes an effort to stand on end and our eyes to dilate, so that we may take on a more terrifying appearance.

That is the endocrine or ductless glands doing their job, and the blood helping by distributing the hormones which they *secrete* or manufacture. (Endocrine simply means secreting internally.) But this business of "summoning up the blood" is only one of the more spectacular jobs of the endocrine glands—indeed it is not really typical, since a *nervous* message is needed in this case to set the process going. The pituitary gland controls growth; the thyroid controls what is called metabolism. Metabolism is Greek for *change*, and biologically it means the changing within our body of food into living cells. If, therefore, we have too active a thyroid, we live too fast, burn ourselves up too fast. If babies are born with too little they do not develop properly—they are cretins (the same word incidentally as Christian, so named when the Romans thought that small sect "barely human"). In animals who hibernate it is their thyroid which conveniently slows things down for them so that they may sleep and not waste away; and the tadpole cannot turn into a frog until its thyroid lets him.

The blood's efforts to keep us at the right temperature and to protect us from the bacteria of disease have an intimate bearing on each other.

There is another kind of corpuscle in the blood besides the red one which carries haemoglobin; it is called either a *leucocyte* or a *phagocyte*, which means a white cell or a consuming cell. The latter is more descriptive, since these white corpuscles actually absorb and devour the trespassers into our blood.

The trespassers are, of course, the bacteria and the even smaller disease viruses, which get into our blood system, either when we break the protecting wall of our skin or else with the air we breathe or the food we eat. Many of the last are killed by our digestive juices, but some are not; for these the warmth and protection of our body afford an ideal breeding place.

As for control of temperature, we are, as warm-blooded creatures, normally warmer than our surroundings but yet able to survive in temperatures very much higher than our own. All the time, but to varying degrees, our muscles (and to a lesser extent our other active organs) are producing heat, and most of the time we are losing heat to the outside air. How does our body effect control? The answer is, partly by the cooling effect of sweat on our skin, but also partly by the capillaries (little veins) near to the surface of our skin, which dilate when we are too hot, and so get the benefit of the cooling air, and which contract and so do the reverse when we are too cold.

But once again conditions may be too difficult for our protective mechanisms. We get chilled and the temperature of our blood momentarily drops. Directly that happens the white corpuscles lose most of their powers of policing and devouring the invading microbe—they, as it were, don't feel too well themselves. Note that in fact when we get a chill two things happen—an actual chilling, and a loss of protection by the phagocytes from such ubiquitous invaders as the virus of the common cold.

So ends the somewhat lengthy lesson on the blood. But before we go on to talk about the reproductive power of the cells of our body, and from that to our nervous system (which will lead us on to our brain and so to Psychology and the next chapter), let us say a little about the food which our blood so obligingly carries around.

There is a great deal that could be said about food. One might speculate historically on how mankind gradually learnt what was good and what was harmful: probably a long and painful process. One can think again of that cycle of food and life that we learnt of in biology, and remember the fact that if it were not for both bacteria and plant life we should all starve. Or one can talk of proteins and carbo-hydrates, and vitamins and calories.

That is what we shall talk about now. But not at great length. There can be too much of that sort of thing, and it is undoubtedly better, and pleasanter, to be a natural and restrainedly hearty eater than a worried and dyspeptic crank. There is, however, a middle way. . . .

Take the word calory first. That has no connection whatever with proteins and vitamins and so forth. It is simply a *measure.* And it is a measure, curiously enough, of nothing more complicated than the amount of heat a given volume of food would give out if actually burnt. We know that in respiration we oxidize or virtually burn our food to produce energy. From the energy-producing point of view, therefore, this heat index is perfectly satisfactory.

But do not forget that it ignores a number of other factors and other properties of food, in particular the power of food to help build up and maintain our tissues. When we say, for instance, that chocolate has considerably more calories per pound than kippers we have said something useful from a purely energy-producing point of view, but have definitely not told the whole story in the matter of comparing the food values of chocolate and kippers.

That brings us to the three main types of food: carbo-hydrates, proteins, and fats.

Carbo-hydrates we need in order to supply our day-to-day energy; proteins we need to repair and replace our tissues; fats we need to pad our delicate organs rather as we would pack a wrist watch in tissue paper, and to give us a reserve of food if we have to starve for a while. (Don't be afraid to starve for a while!) From this we can see that the *measure* of calories has most significance where carbo-hydrates are concerned; nevertheless, both fats and proteins *can* be used by our body merely for energy-producing purposes—which means that to eat more than a certain quantity of these (a relatively small quantity compared with carbo-hydrates) is both socially wasteful and a dangerous overloading of our bodies and digestive system.

Carbo-hydrates is a cumbersome word. It means simply those foods which are comprised mostly of carbon and hydrogen. They are mainly the vegetable roots and tubers and grains—potatoes, flour and so forth. Our digestive juices break down the complicated molecules of these carbo-hydrates into sugar, or rather into glucose which is the form that sugar takes in the fruits of the earth (it is sometimes called grape sugar). The only advantage, from our body's point of view, of glucose over sugar is that part of the digestive process is done for it already and the changing into energy is a comparatively simple matter. You will remember mention of the pancreas as a producer of digestive juices. It produces insulin, and controls the amount of glucose that gets into the blood stream and so to our muscle cells: if you are diabetic your pancreas does not do the right thing and you have to take insulin to restore the balance.

Fats hardly need explaining; and proteins are the flesh foods—meat, fish, eggs—together with a smaller proportion in the natural grains and seeds—peas and beans and so forth.

And having said that, as we all know, we have *not* completed the picture.

There remain what are often called the *protective* foods—foods that we need in quite small quantities to keep us in health, or protect us from ill-health, and without which, however much we stuff ourselves with food that lacks these things, we shall "sock awa'" and wilt as inevitably as a flower out of water.

This is where, incidentally, we begin to have to forget the machine analogy for our body. In supplying an internal combustion engine with petrol or a jet engine with paraffin we don't have also to administer infinitesimal particles of a whole lot of other things as well. By no logical argument should such small amounts of the protective foods make such a disproportionate difference.

These protective foods are the mineral salts and the *vitamins*. The three most important mineral salts for our body are calcium, iron and phosphorus. A serious lack of iron, for instance, causes anaemia; complete lack spells death. Yet we never need more than one-tenth of an ounce of it in our bodies.

The vitamins are even more inexplicable from a purely quantitative point of view; we still don't know the complete "why" of them. But we do know that we need them, and that the most magnificent diet will keep nobody in health if it lacks these infinitesimal essentials. A table shows the most easily what we need to know about them—look, therefore, at the one below.

VITAMINS SIMPLIFIED

Vitamin	*Found particularly in*	*Needed for*
A	Butter, egg-yolk, tomato, green vegetables, fish-liver oils.	Sound growth and resistance to infection.
B	Wheat, yeast, animal liver.	Healthy nervous system and skin.
C	Orange, lemon, black currant, hips.	Healthy cellular respiration and (again) resistance to disease.
D	Egg-yolk, butter, fish-liver oils. (Also made in our own bodies when we sun-bathe.	Sound bone and teeth formation.

And one more thing needs saying of them. It is only the fact that an over-urbanized way of life may lead to the lack of them that makes us need to worry about them at all. Live on chalk-white bread, things out of tins, everything cooked, and with a scorn for "rabbit food", and you will either be wan and sickly, or need to take vitamin pills, or both; eat a more natural diet, and you can forget vitamins except as something of a purely impersonal and scientific interest. . . .

. . . . .

We turn back to cells, and come to the Reproductive System.

Bear this in mind: that, apart from water and mineral salts, our body is made up completely of cells and what those cells have secreted or go on secreting.

That is our body: cells of amazingly different shapes and sizes, functions and specializations. They are, as we said in our Biology chapter, very much the same sort of thing as the simplest primeval form of life, or rather its still existing equivalent, the amoeba; they increase in the same way, by splitting off and multiplying. We are in fact a most amazing thing: not one life but many lives—myriads of lives, a great collection and colony of lives. We come back indeed to that biological conundrum of identity and individuality. There is no doubt here of course as to who or what is the individual; it is ourselves, our body, governed and directed by our nerves and brain. Nevertheless, this fact remains: our body is a co-ordinated mechanism of other bodies, the cells; and these cells, though under control, have an entity and a life of their own. Not only that, but *they continually die and continually renew themselves*.

That is quite a different matter from our whole body dying. When that happens, if it is not through infection or accident, it is a general wearing out of the machine. The cell, however, has what we may call a vicarious immortality; part of it at least, every time it splits, goes on—and on—and on.

And that too, surprisingly enough, is fundamentally what we humans do in a particular instance: when—to use a coldly biological term—we proliferate and reproduce, when we beget and give birth to children. With us humans, however, it is only a very small part of our bodies, certain very specialized cells, which perpetuate themselves. They are called the *gametes*, or marrying cells, the ovum in the female and the sperm in the male.

We have come to Sex, that frightening word. Why should it be at all a dread word? There are books which describe the mechanism of sex in human beings. But it does not look well in cold print: it is not possible for us to be wholly natural and unprudish in those matters —we shall see in the chapter on Anthropology that it is only the primitive man who can be that. It will not, then, be described in this book.

But remember the chapter on Biology; remember the idea there expressed that sex is a means of reproduction that is found with remarkable similarity throughout life, both animal and vegetable. With humanity it is sublimated to its highest degree, so that carnal love and spiritual love are intertwined inextricably and mutually enhancing.

Remember, too, that the sexual method is, for life as a whole, only one method of reproduction but by far the most successful method from the point of view of heredity and evolution.

We can say a little, but a very little, on *Heredity*, a tremendous and a growing science in itself.

First, one should get this idea into one's head: heredity has a *physical* basis. (In other words it does not depend on what the pregnant mother sees or feels or hears or imagines, except in so far as all that can affect her physically—and that in spite of all the old wives' tales to the contrary.) Heredity depends on *chromosomes.*

What are these chromosomes that we mentioned so briefly in our Biology chapter?

They are the *essential individuality* of the cell. Physically they are microscopic rod-shaped entities (not necessarily straight rods) which become active and do strange and wonderful things when a cell in the body of a living being prepares to perpetuate itself by splitting.

It was in the observation of this splitting process of a cell that the chromosome was discovered. The cell divides by forming a sort of waist which gradually reduces to nothing and so effects the split. Into this waist, it was observed, congregated these curious rods, writhing and very active. Further, these rods, it was observed, went about in pairs; and when the cell split, one of each pair invariably *went into each of the new cells.*

After all, one might indeed say, something like that must happen. The cells of our body are not just any cells. They are *our* cells, not the cells of Tom, Dick or Harry, not the cells of an elephant, a sea-louse, or a poppy, but of a particular human being. They must, in unscientific language, *know* what to be and to do; they must be able to create the right "pattern" of life, not only in the whole but chemically in each molecule. They have the means to do this, the requisite kit of tools, in the chromosomes. No cell in our bodies is without its chromosomes; no cells—with one exception—have either more or less than a complete and identical set of chromosomes.

And these exceptional cells *are* the sexual cells, the ovum of the female and the sperm of the male. Now these two cells are to fuse and proliferate to make the new body, the new life, the baby; and the baby's cells must each have its set of individual chromosomes. But *not* a double set. The simple and the obvious other essential thing happens, therefore: our sexual cells have just half the number of chromosomes.

Perhaps we now can begin to see how this all connects up with heredity. People have always known that in practice children "take after" their father as well as, and on an average as much as, their mother. But it was a little hard to see how this could be so, seeing that the physical process of growth all occurred in the mother's womb. Now we know the answer: this fact that the first cell of the new life contains a complete *single* set of *both* the chromosomes of the father and of the mother. And since all the cells of a body proceed from the original cell, and since whenever a cell splits it bequeaths a complete outfit of chromosomes to each of the two resulting halves, then *all* the cells of a child always contain the chromosomes bequeathed to it in equal part by each of its parents.

The chromosomes are, as it happens, just large enough to be seen by a powerful microscope. But we come now to the ultra-microscopic, to what we know must be there but can only deduce. It is rather like the business of the atom and the electrons and so forth into which physicists divide it. Indeed the analogy goes further, since the chromosome is the fundamental brick in heredity just as the atom is the fundamental brick of the universe, and yet in each case we discover that there is yet a further subdivision.

The subdivision of these little rod-like chromosomes—a thing, remember, which must be there but which no one has seen—are called *genes*. (It simply means "beginnings", the same word as genesis; pronounce it to rhyme with several girls of the name of Jean.) They lie ("like beads", as we said earlier, "upon a string") along the length of the chromosomes—that much has been proved experimentally—and *they govern our characteristics*. They govern our physical characteristics, the colour of our eyes and the curliness of our hair, whether we are likely to grow tall or short, whether we shall be congenitally deaf, or weak in the liver or weak in the head. They must govern too —though nobody has got so far as to prove it—whether we are clever or dull, whether we have an ear for music, the hand of an artist, or a taste for mathematics. In other words, they control our heredity.

Thus every human embryo (the name for the new life in the womb) is from the start given a set of characteristics, of potential virtues and vices—not by the good and bad god-mothers of the fairy story, but by a mixture in infinite variety of the genes of the two sets of chromosomes bequeathed him irrevocably by his parents.

It is a fascinating subject, this science of heredity and human beginnings, which we call *Genetics*. Can that chance sorting-out of the genes ever be controlled, so that geniuses or good honest hard-working ordinary folk can be turned out to order? It will be a very different world if that ever should happen. Can we at least weed out the unquestionably unwanted genes, such as that one for deafness? We should surely get a better world if we could do that. At least we see before us an example of the tremendous potential powers and responsibilities of science.

It is possible at any rate to shed some scientific light on that hoary question: which has the most influence, heredity or environment? The answer is that they are both always there, indestructible, equally important, and always acting upon each other. Experiments have been made with the humble and ordinary bean (for in this and other things all life, vegetable and animal, is governed by the same laws). The bean is a vegetable that pollinates itself; in other words, mother and father are the same and there is normally no change in the genes between one generation and the next. What would you expect if you bred regularly from always the smallest bean on the one hand and the largest on the other? Surely smaller and smaller or larger and larger beans. But no! It was found that on an average there was no difference. Smallness and largeness were products of better or worse environment in each case. The potentialities, the *inherent* powers of the bean for sun and rain to work on, were the same; only by mixing strains, by choosing the right genes, could bigger and better beans be obtained.

Not only are these genes of the chromosomes immutable and indestructible, but they are in a strange way capable of lying dormant, rather as a poppy seed can lie dormant in the ground. There are, it has been found, what are called *recessive* and *dominant* characteristics of the genes. And the recessive can be unapparent but still existing in a generation—that generation can as it were be an unconscious carrier —until on meeting a similar recessive characteristic in the next generation it can come out. Thus two brown-eyed people can carry blueness-of-eye recessively within them, and so can have a blue-eyed baby if they marry. (But not vice versa, since brown-eyed-ness is dominant and so cannot lie hidden.) There we have the reason why it is dangerous for near blood relations to marry: since similar recessive, and evil, characteristics have more chance of meeting and appearing in the next generation (though this, of course, applies equally to good characteristics).

We cannot carry this further; it is a huge subject. One final rather romantic fact. The real founder of this science, the propounder of the "Mendelian" theory of recessive characteristics—that benign Austrian abbot experimenting quietly and gently in his monastery garden—published his theories in 1865 and died a disappointed man because no one would take any notice of them. Not until the beginning of this century did other scientists revive and elaborate his ideas, set the science of genetics on its rapid growth, and vindicate the old abbot who had worked amongst his flowers.

And now finally let us look at our body's *nervous system*.

It is obvious that when we consider such things as hormones, the microbe-absorbing white corpuscles of the blood, and the inexplicably disproportionate effect of vitamins in our diet, the analogy between our body and a machine is wearing very thin and is in fact better forgotten. This is as true when we come to our system of responses and controls of our nervous system. No machine even begins to have the responses and controls which our body has*; indeed one's normal conception of a machine is that it has to have a minder. Our body, or rather our body-and-brain, is machine and machine-minder in one. Nor is that really a true analogy; for on the one hand the brain is much more than a director of our body, it is the seat of the consciousness, the memory, the imagination; and on the other hand many of our nervous controls are exercised by organs subsidiary to the brain proper, collections of nerve cells and ganglions of which the chief are the cerebellum, just below the brain proper, the spinal cord, and the solar plexus.

The only useful machine-analogy when considering our nervous system is to compare it to a telephone system, complete with wires and buzzers and an "exchange".

But before we go any further, let us be clear about this word *nerves*. We use the words nerves, nervous trouble and the like so laxly in our ordinary conversation, meaning anything from the mental results of our nerves' activities to sheer fright and cowardice, that it is a little hard to remember what the nerves of our body in pure physical fact really are. Our nerves are made up of cells as is the rest of our body; they are just particularly sensitive cells and very specialized ones, which both give and take messages.

That is the first thing to remember, that they both give messages and take them. It is a *two-way* system.

Take a typical nerve cell. It is very big for a cell. Situated in the spinal cord, it will send out a long, gossamer-thin thread of its own protoplasm, out through the body, to one of our sense organs—sight, taste, touch and so forth. Other threads will go to our muscles, to carry messages and not to receive them. Other threads will connect one nerve cell with another. The system is amazingly intricate, and the nerve fibres amazingly delicate. Further, our nerves are not a single fibre but a bundle of them—just like a bundle of telephone wires which you sometimes see in uncovered manholes in the road—but the nerve fibre is a tenth of the thickness of a single hair!

It is not easy to give an idea of the intricacy of our nervous system without going into elaborate detail. But remember that it is not only our ordinary motor muscles, those that cause our external movements, that our nerves control. The rhythmic movements of our digestive

* The nearest to it is the electronic calculator—see Chapter XXI.

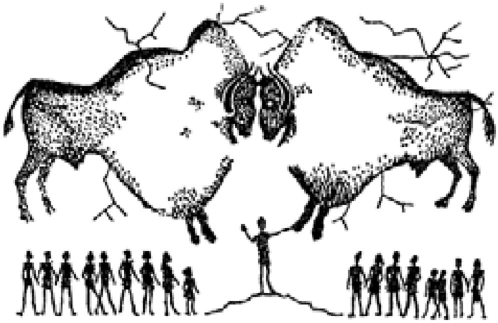
organs, and our breathing, need continual messages or orders to keep them going—not, fortunately, controlled by our cerebrum, our conscious brain, for we do not need to *think* about breathing. Remember, too, how necessary it is that our reflex actions, as they are called, should be quick and immediate: recall the jumping-out-of-the-way from impending accident, where the adrenal glands come into the picture, but only of course to act upon and through our nerves.

Then there are messages coming in from other sources than the obvious ones of the five senses. There is a subtle sense of balance which is given to us by an ingenious system of "semi-circular canals" in the inner ear, little tubes set in three different planes and filled with fluid and sensitive hair-like nerves. Think finally of such a seemingly simple action as walking, and then recall for a moment the unfortunate who, merely because his nervous system is impaired, becomes at once a pathetic, trembling and shuffling figure of pity.

Our nerves are delicate and subtle in the extreme. They are, indeed, the controlling mechanism of the body of that most sensitive of all God's creatures, Man—a body that we now perhaps appreciate a little better as being most certainly fearfully and wonderfully made.

And at the back of it all, *exercising* the conscious control, is our brain. Is that sensitive and subtle and complicated too? The psychologists tell us, with no hesitation, and much detail (and some disagreement amongst themselves), that it is indeed sensitive and subtle and complicated. We will spend the next chapter in attending to what the psychologists say.

BOOKS: It is enough to repeat for this chapter the two main books recommended at the end of Biology: *The Science of Life* and *Man and Other Living Things.*



CHAPTER IX

THE HUMAN MIND AT WORK

(Psychology; Anthropology; Analytical Psychology)

WHICH is it correct to say, that Psychology is the Science of the Mind or of the Brain? The answer is that it is the Science of the Mind.

And yet it is not easy to say what is the difference between Mind and Brain. We know what brain is, physically: it is our "grey matter", it is the delicate spongy mass of nerve cells, mostly a pinky-grey *cortex* or rind, complicated into a very intricate maze of convolutions to give itself, as it were, more working space within the limiting skull that protects it (rather as a quick-boiling kettle gives itself more area for catching the heat).

But to define Mind is not so easy. We can perhaps say that it is the non-material emanation of the brain: what the brain does, the result of the brain's physical workings. We could say too that it is the seat of *consciousness*, of our thinking, feeling, willing, knowing, imagining.

Now, here we cease to talk in hard scientific, material terms. We come up in fact against the difficulty of finding the right words, a difficulty which we shall always meet when we leave hard facts and material things. Nevertheless, we must persevere—and at the same time be careful.

Has an animal a mind? Definitely! Yet, where do we draw the line? If a dog has a mind, then has a fish, has a frog, a worm, an amoeba? Evolution forbids us to say facilely, "*here*, mind begins".

Biology tells us that as living species grow more clever at responding to their environments their nervous systems develop, from the simple reaction of the amoeba to light or food, through the mere dispersed tangle of nerves of a jellyfish, to the control centres in the backbone of the vertebrate and to the real brains of the reptiles, birds and mammals. We can only say, therefore, that it is all a matter of degree; that where there is any brain at all, then there also must be mind and consciousness, even though it may be so undeveloped, so infinitesimal compared with our own, that we can hardly begin to appreciate what such dim and embryo consciousness means to its owner.

And that of course is the great thing to realize: the tremendous difference in degree in the mind and consciousness of Man on the one hand and of all other living things on the other: *that*, above all, is what differentiates us from the rest of the animal kingdom.

We need to consider this word Consciousness for a moment—taking a few cautious steps into the realm of Philosophy to do so but walking out somewhat hurriedly before we lose our way.

Philosophy makes a great and important distinction between *subjective* and *objective*—two words which you are likely to meet often in all sorts of places in your reading and which will put you at a disadvantage unless you have some idea of their significance. To consider a thing objectively is to consider plainly just the material thing itself; to consider a thing subjectively is to consider it from the angle of one's own awareness, one's consciousness of it, one's idea of it. It is easier to consider a brick objectively than subjectively. But when we come to, shall we say, hiccoughs, it is rather the other way round. As for such abstract qualities as goodness and evil, it is hard to say whether they have any objective reality at all. And do not forget that even with such a material thing as a brick, the brick itself and one's consciousness of it are not the same thing. We do not really *know* what is the other fellow's consciousness of a brick; we only have a pretty good idea—a very good idea in fact—that his consciousness of it is the same as ours because he reacts in the same way: particularly, for instance, if it hits him. In philosophic language, there is a *dualism* in everything: the material object, and our subjective consciousness of it.

But we will not let that worry us too much. We will retire now from the philosophic realm—having only trespassed so far in order to impress upon ourselves that this idea of consciousness and mind is a new idea and something quite definitely not wholly explainable in physical terms. In fact, to explain what happens in the brain when one talks and thinks, to explain it in terms of nerve currents and energy and electricity and blood-flow, is interesting and significant *but it is not all.*

Nevertheless, we do need to start Psychology with a physical description of the brain.

The brain proper we call the *cerebrum* (merely Latin for brain), or sometimes the cerebral hemispheres, since our grey matter is divided into two halves within our skull. This is distinct from the *cerebellum*, which we described in the last chapter as controlling our movements (though always under the final selective direction of the brain proper), and distinct too from those nerve centres in the spinal cord and the solar plexus which control the automatic business of breathing and digesting and so on. Remember that an animal can still live without a cerebrum or brain proper. But it cannot be *aware*. The brain is reserved for higher things: this awareness, or, to come back to our word, Consciousness.

The brain produces consciousness by receiving and co-ordinating, by considering and by exercising choice upon, the messages of our five senses, sight, smell, hearing, taste and touch. That is the brain's job.

This brings us to the different regions of the brain. Over a hundred years ago a German physician by the name of Gall propounded a theory that different regions of the brain corresponded with different mental or emotional characteristics. He noticed that a certain musical prodigy had a peculiarly bulging forehead, that a somewhat over-amorous lady had a bump somewhere else. He started *phrenology* or "feeling your bumps". Unfortunately he committed the scientific sin of arguing too easily from the particular to the general—and to do him justice he had not then a tithe of present knowledge behind him—and he was completely wrong. Phrenology is as completely a bastard and a pseudo science as astrology.

Nevertheless there *are* particular regions of the brain receiving and dealing with the different senses. Indeed a highly interesting part of biology can show you just how life's climbing of the evolutionary ladder is reflected in the make-up of the brain. The animal who has learnt to be clever in trees has the part of his brain which responds to touch and sight developed at the expense of the part responding to smell, a part which in the lower animals in bigger than all the rest put together.

Man goes further, of course. Both he and the higher animals have a front part of their brain which has nothing to do with any of the five senses but which is connected with *other parts of the brain*. This front part is called the "Association Centre". It takes any or all of the senses and "thinks" about them. *And in Man this part is enormously developed compared with any other animal.*

Let us try to understand a little how this business of thinking works. It introduces us to a fresh name in science, Pavlov. Pavlov was a Russian scientist who died at a ripe old age in 1936 and who in his house and laboratories in Leningrad experimented upon dogs. (And before we go any further, do not let our minds be clouded by emotional reactions upon the subject of vivisection and cruelty to animals. Undoubtedly scientists have at times been guilty of unnecessary experimenting which has only resulted in their stating the obvious in grandiloquent and relatively incomprehensible language. Undoubtedly, too, anti-vivisectionists at times have been guilty of tremendous exaggeration and have talked a lot of rubbish. Pavlov was, within his own lights, kind to his animals. But whatever he was, you will, if you want to learn, dismiss your opinions on such matters at least while you read "objectively" about the work of this scientist, and the conclusions that we can draw from them.)

Let us go back for a moment to that illustration we used in the previous chapter, of our skipping out of the way automatically to avoid the possibility of being run over. We do that "before we have time to think". It is just a reflex action. Scientists call that sort of behaviour a *simple* reflex action. We see the vehicle bearing down on us—and we move! It is really a collection, one might say a symphony, of simple reflex actions: our sight and hearing send messages to our brain and the brain directs lesser nerve centres to set going the multiple and complicated messages to our muscles which enable us to work our body and legs with remarkable skill and dispatch.

Pavlov however dealt with what he called *Conditioned Reflexes*, something less simple and direct, something that brings in an element of learning and remembering.

When one is hungry and sees something particularly tasty one's mouth waters. So does a dog's, only more so. Pavlov used this simple fact in his experiments. A dog was given his dinner and at the same time afforded some sign, a flashing light, for instance, or a ringing bell. After this had been done several times, there began the process of lengthening the time between the sign and the meal. The dog responded by his mouth-watering to the sign and not to the meal, and continued to do so even when the lapse of time between sign and what the sign meant became really considerable. He had in fact *learnt* something, and his reflex was not a simple one to the meal itself but a conditioned one to something that meant that a meal was coming. A link had been made not merely between the brain and a muscle but between one part of the brain and another; that Association Centre of the brain had come, albeit in the simplest way, into play.

That was the basic experiment, and illustrates the simplest form of learning and thinking. But Pavlov found that *doubly* conditioned reflexes could be created: a *sign* that a sign that dinner was coming. Further, a dog could be made both to un-learn a conditioned reflex and to distinguish more subtly between the signs. The latter was done, for instance, by making a dark grey visual sign mean dinner and a light grey sign mean nothing. Then gradually the dark grey sign became lighter and the light darker. Still—and to a remarkably subtle degree—the dog could distinguish and give the right reaction.

The process of holding back, of unlearning—of not responding, although if you weren't thinking very clearly and weren't controlling your reactions you would respond—is called *inhibition*.

Now this process of inhibition is important in the canine and in the human mind. It is the sort of thing, on a physical basis, that one does when one exercises skill of hand and eye and holds back the force of one's drive at tennis, for instance, until just the right split second; or one exercises inhibition in not "going off the handle" but, rather, holding oneself back and being reasonable. It is significant that too much training in inhibition made some of the dogs "nervy", made them indeed have something like nervous breakdowns: we begin to see a little what we mean when we speak colloquially of "nerves"; our own neurasthenia is, we might say, the same thing writ large.

Another thing: it was found that a too often repeated lesson might send a dog to sleep. A good deal was found out about sleep: that it is an active not a passive thing, a definite shutting down of the higher faculties of the brain, that there can be partial eclipses, that indeed it is not very often that all the parts of a brain are awake at the same time, that hypnosis has a definite relation to sleep and is in fact nothing queer or mysterious but scientifically explicable. . . .

We at least begin to appreciate perhaps that the human brain is a vastly subtle and delicate mechanism. For remember that our brain and the dog's are only the same in so far as they are both mammalian brains; ours is even much more subtle and complicated. Whereas the dog has a conditioned reflex, our speech and thought and actions can well be governed by what we might call reflexes conditioned to the *n*th degree. Particularly is this so in the matter of speech. This fact is significant: any injury to that fore-brain of ours, the Association Centre, affects directly our powers of speech. Man has a much bigger Association Centre in his brain than any other animal; *and man is the only animal that can talk*. We forget how much we have to learn when we learn to talk. For each word is a symbol, a sign; involves a conditioned reflex. It is very true to say that the conditioned reflex is the basis of learning. The Association Centre of our brain is a super telephone switchboard, a labyrinth of connecting links set up by memory and learning and the experiences of our childhood—a symphony, if you like, of conditioned reflexes.

Mention of childhood can lead us conveniently from Pavlov to the work of other modern scientists.

Let us think of a conditioned reflex set up in the new, blank and open mind of a baby. A baby seems to hate and fear only two things instinctively, a loud noise and the feeling of being dropped. The rest it has to learn. It does not even fear fire—until it has either been taught or has learnt by bitter experience, that is to say by having the automatic or simple reflex of taking its hand away from the hot thing turned into a conditioned reflex of "hot thing—nasty!—keep away!" And so to teach by conditioned reflex is the simplest and most lasting way. Proffer something pleasant and at the same time frighten the baby with a loud noise, and the baby will fear and avoid that thing. And vice versa, if you want to un-teach such a conditioned reflex you will never do it by sweet reasoning, but by the opposite process of gradually substituting a pleasant accompanying experience for the unpleasant. This idea was used in Aldous Huxley's cautionary novel of an over-regimented future, *Brave New World*, where worker-slaves were conditioned from birth to like drudgery and hate the beautiful and expensive things of this earth. That of course was an intentional exaggeration. But it has indeed been proved how plastic and blank and open is the human mind at birth. It is not written over by instinct; we are easily the animal in the world least ridden by instinct. Practically all that we learn, in fact, however "instinctive" we may call and consider it, we have really, by these often hard and painful methods, *learnt*.

How difficult indeed has learning been for the human race!

The significance of that is the next point for us to realize: the significance of the fact that the human mind, besides being a wonderful instrument, is also an imperfect and a not always easily manageable instrument.

It is delightfully simple to be equipped, like an insect, with an elaborate set of instincts at birth; but it is not a flexible equipment and it doesn't get one very far. It must be delightfully uncomplicated to be an animal, whose brain has only the most embryo powers of true reasoning—most of us at times must have envied the cat before the fire, the gambolling puppy, the cow placidly chewing the cud. But, again, it doesn't get one very far. Man has the birthright of his immeasurably superior brain: *Homo Sapiens*, the reasoning animal. But, like all good things, our brain has its dangers and its responsibilities. We have found it *difficult* to have a big and complex brain. We still do.

Paradoxically in fact, although we call Man the Reasoning Animal, he is not so reasonable as all that! His mind does not work perfectly, in a vacuum. It has grown and evolved with his body; it is housed in his body.

There are two concepts to be appreciated now; and they both lead, particularly the latter, to the sciences of Anthropology and modern or Analytical Psychology, with which the rest of this chapter will mostly deal. They are these: that we must really think not of a separate body and a separate mind for Man but of a combined something, the *Body-Mind*; and secondly that behind the modern civilized mind of us all there exists, influencing us all the time, an animal mind, a child mind, and a savage or primitive mind.

Take that body-mind first. This is a quotation from a book, *Mind in the Making*, which will be listed at the end of this chapter:

> "What we think of as 'mind' is so intimately associated with what we call 'body' that we are coming to realize that the one cannot be understood without the other. Every thought reverberates through the body, and, on the other hand, alterations in our physical condition affect our whole attitude of mind. The insufficient elimination of the foul and decaying products of digestion may plunge us into deep melancholy, whereas a few whiffs of nitrous monoxide may exalt us to the seventh heaven of supernal knowledge and godlike complacency. And vice versa, a sudden word or thought may cause our heart to jump, check our breathing, or make our knees as water."

This is only a particular and striking way of putting what must always have been more or less obvious to everybody. Of course we have feelings and emotions as well as thoughts. But in treating of the mind it is all too fatally easy to isolate it for examination when in fact it cannot be segregated, and the early psychologists fell perhaps more easily into that error for lack of our modern knowledge of physiology. It is for instance no doubt picturesque, and sometimes telling, to speak of the heart (and not the mind) as the seat of the emotions, and we shall probably always continue to do so. But it is rather obviously inaccurate.

We need hardly pursue that matter much further. It is a warning, it needs remembering. We might say, to help clarify our thoughts, that this chapter is not about Mind but about the "non-physical attributes of the body-mind: consciousness, thought, will, imagination, feeling".

And we must add *day-dreaming*, *self-deception*, *superstition*, if we want to stress—as we do—the idea of the imperfection, the uncontrollability, and the recurring unreasonableness of our "reasoning" mind.

We come back to the second of the two new concepts to be absorbed: the mind as a legatee of previous minds, those of the animal, the child and the savage. That brings us to the Science of Anthropology.

Anthropos, *Logos*: two Greek words meaning Man, and a Word or Dissertation. This, then, is the Science of Man, a very wide definition. But in practice by Anthropology is usually meant the study of primitive societies, their customs, traditions, beliefs. It will teach us much of how men have learnt to live together in amity (or perhaps rather how they should or might have learnt); we shall come across it again therefore when we touch on Laws and Institutions and Administration. But it also teaches us much of how primitive Man's mind worked, and that is what we are concerned with here. It is really an aspect of history, or at least of early or unwritten or "pre"-history, and one at least hinted at in Chapter VI.

Anthropology is not likely to be one of those subjects which we are relearning in a rather different way after leaving school. Indeed, the very opposite, it is a subject which very many people never realize exists at all. That is a pity. Not only have they missed something extremely fascinating, but their outlook on human nature will be very incomplete without it. Anthropology opens up a new vista, a view of that brave, sometimes pathetic, often tortuous and occasionally terrifying struggle of Man to use properly his quite overwhelming gift of mind and imagination.

That it should have been a struggle at all will not surprise us if we continually bear in mind the fact that Man is descended and evolved from forms of life which got on very well with remarkably little brain. Man, the animal, was faced with the Universe, with Nature, and he had to learn to understand Nature before he could begin to control it.

What is more difficult for us to appreciate is just how bewildering and overwhelming Nature must have seemed to primitive man and how utterly dependent upon the kindness or otherwise of the elements he undoubtedly was. It is nothing so easy and simple as that he had no factories or shops, no towns, or electric light, or books. He had not even, to begin with, a language with which to express his thoughts. Not only had he no shops, but no store of any sort, no reserves. (We have seen the significance of the *reserve* in building up the first civilizations.) If you failed to kill your quarry, if you failed to grow your crop—then, quite simply, you died. Then, too, what protection had you from the hurricane, the blistering drought, the sudden inexplicable lightning shaft from on high, the forest fire? And, above all, what caused them?

Whereas, if you were a primitive man, you did not need to know the Three Rs, you did need to know the habits of the animals you hunted, and the cycle of the seasons. Two great facts that were really one great fact were impressed upon you: that men and animals increased by giving birth to young, that crops grew from the earth. Both were: *fecundity*, "the earth's increase".

If only you could *control* that increase! Fecundity was the thing that mattered; to make more fecundity was the thing that mattered more.

And so we come to the inevitable fact that early man—and so ourselves insofar as our mind, our unconscious mind as the psychologist has it, is a legacy of the primitive mind—is interested in sex. Yet at once we give something of a wrong impression. Primitive man was interested, as we have said, quite openly and unashamedly, but very intensely, in fecundity, both for himself and for the rest of Nature, animal and vegetable, which he sought to control. That is something much bigger than being "interested in sex". If his mind ran on phallic symbols (see the dictionary), it was not because he had a nasty mind, but rather at one and the same time a severely practical and a very muddled mind.

His mind did run very much on symbols. *Symbolism*: there is another very important idea to grasp. Symbolism permeates Man's mind through the ages. It still does to some extent—indeed to a larger extent than we think.

What is a symbol? Simply something that *represents* something else. But it has this magnificently useful attribute: that it represents more than the thing itself; it has as we say "a wealth of associations". Think of the word *flag*. How much more that means than a mere coloured bit of bunting! "I am loyal to the flag." Think of other symbols which we still use: the Cross of Christianity, the Hammer and Sickle of Communism; badges, emblems, old school ties. They concern our loyalties and emotions, not our reasoned thoughts. No wonder that Primitive Man thought in terms of symbols: an animal has emotions, reasoned thought had to grow. In a way, all words are symbols; but symbolism surely existed before words.

Primitive Man went further than this. He gave everything a soul, a personality. That is called *Animism* (Latin, *anima*, which means life, the soul, or breath). We do something of this when we are children—or childish. "This beastly pencil," we say, "it won't sharpen!" Naturally and in the same way, when things in Nature would not be accommodating, men thought of them as having an active and evil intention against themselves.

How to control these difficult things, with no science, no knowledge behind you: that was the task. Man hit upon a pseudo-science, using symbolism and animism in a gorgeous, muddle-minded jamboree to the top of his bent. We call it *Magic*.

This was not the mixture of self-hypnotism and mass-hypnotism and worship of evil which still lingers in the world and is called "black magic". It was what is usually described as sympathetic or—more helpfully perhaps—imitative magic. You said, "This waxen image I have made of so-and-so (whom I hate): it represents him, it *is* him: I'll stick hot pins in it, and he will die." You even said (as in the fairy stories): "I have discovered so-and-so's real name. His name *is* him. I have power over him now." You said—in a more kindly mood—"So-and-so has warts. I will rub them with a piece of bacon, cut a slit in the bark of an ash tree and slip the bacon into the bark. Then the ash-tree gets the warts—look at the little nobbles on its trunk!" (If you are ignorant or superstitious you do that sort of thing still, and a thousand other things like it, without even knowing of the false reasoning that was once behind it.) Or you, if you were primitive man, said, "I want rain." (And to us urbanized holiday-makers it is surprising to know how much people did want rain.) Now rain is water, you said; I will therefore sprinkle water about in a solemn and ritualistic manner—or, better still and more impressive and effective—I will throw somebody down into water. Then of course the rain will have to come down too!

That is imitative magic. It has been rightly called a pseudo-science, science based on a hopelessly false premise. But it can also be called the first glimmerings of religion, or rather a forerunner of religion. You seek to control Nature, solemnly and impressively. And, to make it more solemn and impressive, you have an expert on the job, the "witch-doctor" (a not very accurate description, however), or as one might say, the first priest. From *magicking* Nature you progressed—since even you could see that it wasn't always working—towards *propitiating* Nature. You reached the sacrifice, often the human sacrifice.

Historically this brings you past the hunting era to the crop-growing era. Primitive crop-growing is saturated in superstition and blood-sacrifice, permeated with the idea of kings and gods and king-gods who *represented*, by their own fertility and in their own dying and resurrection, the fertility of the corn and the death of Nature in winter and her wonderful revival in the spring.

All this is very confused, very strange to us, sometimes very cruel and horrible. A study of it will show whence come—changed and sublimated—many of our own religious beliefs. But that is not to deride or debunk true religion; all this primitive stuff was a genuine groping towards the realization that men after all could not control Nature or their own lives unaided, that there was something Greater-than-Man behind him, if not yet one single God at least gods and goddesses innumerable and fantastic.

Anthropology is indeed an immense subject, compiled with great patience from the customs and beliefs of extant primitive tribes, and from the myths and memories and folk-lore of less primitive people which give a clue to what true primitive man really felt and thought.

But we cannot follow it much further. *Totem* and *tabu* (or taboo if you like), since they are words one so often meets, we will say something about.

Tabu we know means roughly "*It isn't done!*" But to transgress would result in something much more drastic than a minor social ostracism. From one aspect tabus were the equivalent of our laws and conventions, the social cement that bound the tribe together—we shall come to that again in a later chapter. But from another aspect they were pure superstition, connected with all that business of fertility and sacrifice: the holy king-god's hair should never be cut, nor his nails; no one should ever touch him, should ever cross his shadow. . . .

Totem is something very tortuous. Put over-simply, a tribe chose a particular animal to be sacred to it, and that was its totem. It was partly utilitarian: you controlled your hunting of it and so saw that it didn't die out. But it was largely mystical. Men must have been, naturally, much less conscious that they were different and apart from the animals. And so at times you *were* your totem; or your soul entered its body and its soul entered yours. So you dressed up as it, and danced. *Symbolism* comes back into the picture—and drama and the dance come tentatively and rather queerly into it. . . .

One thing further we will speak of at a little more length: the myth or folk story. Some of our fairy stories are, as it were, the pretty children of these myths, their significance and their symbolism forgotten. Myths tell of heroes and demi-gods and gods—they are all much the same to the primitive mind. They may tell of what must have been real people—of Prometheus, who wanted fire, and "stole it from the Gods", or of the Egyptian Osiris, who taught the people to make use of the flooding of the Nile. But the Myth will do something more than that. For instance, Osiris's adventures are many and fantastic; he is killed and comes alive again, he goes down to the nether world, and is rescued just as was the Greek Persephone lured there by the dark God Pluto. Here we are back to the old ideas of the Seasons and of the ritual human sacrifices which were used to control them. *Myth* is in fact the theory, the story, invented to explain to succeeding generations the *practice* of the ritual. But these myths did something else; they gave too—and this is the main point—scope for Man's imagination. That is perhaps the surprising thing: Man is a story-teller—a poet, and a mystic—from the start. Man's mind is not wholly reasonable nor ever wholly to be understood by reason. Man did queer tortuous things; he gave himself Hell—there is no other word for it—in imposing rules and ritual, and observations, and tabus, all in the name of practical living! And we, modern men, are his heirs, mentally and spiritually, as well as physically.

That brings us to the ideas of modern or analytical psychology. Remember what has just been written, remember in particular about Symbolism, and it will be easier to get some idea of what Freud and other specialists in this subject have meant.

Cast your thoughts back to the second of those two "concepts" which we mentioned some few pages back: the idea that our minds are inheritors of the animal, the savage and the child mind.

We have seen something of how the savage mind had to struggle to become even a little rational. One has then only to think of what is often and rather unintelligently called the fancifulness of children—"Where *does* he get his ideas from!"—to realize that the childhood of the race and of the individual have much in common. The animal mind is further away; but think only of how a *smell* can be nostalgic and evocative! How indeed could it be otherwise than that we should have the legacy of all three in our minds all the time? We do not live and think and grow up in a vacuum. Inheritance is not likely to be only physical.

Yet, one may object, we do not behave like animal, child or savage in our waking, our normal, our rational everyday life. That is true. But it is also true that we are not always awake, or normal, or rational. There is another mind, in fact, besides the mind we know of. There is an unseen, unrecognized, underground mind. It is called the Subconscious, or more often the *Unconscious*, Mind.

That is the great discovery of Analytical Psychology, of which Sigmund Freud (his name rhymes with Lloyd and he died in 1939) is the father: the unsuspected presence, and the unsuspected power, of the Unconscious.

Let us go straight to Freud. Why, he asks, do we dream? Or rather—since he would not deny that the physical cause of dreaming may be something as prosaic as indigestion, or at least something that disturbs our sleep and is wanting to wake us up—why do we dream the way we do?

There is no reason or probability in our dreams. There is no sense.

But there is significance; there is significance because of that one thing, symbolism. Our unconscious mind is hiding things away from our modern, sensible, factual, sophisticated mind. It may even descend to what we should almost call punning. You dream perhaps ridiculously that you are moving the stars about in some map of the Heavens; as you wake you describe that bit to yourself, "I displace the stars." That perhaps is what your thwarted ambitions would like to do: displace the stars of your profession.

Dreams are in fact a safety-valve. They afford a chance for your worries to air themselves, whilst still letting you sleep on: you sleep on because you do not *recognize* the symbolism. Your urges and impulses—often urges and impulses of which your waking, conscious mind would be ashamed—have a harmless airing. The manifest content of your dream, as the psychologists call it, is ridiculous; the real content is significant but hidden by the "censor" which the Unconscious invents and commands to protect you.

That is really rather fantastic. But it is true; it is too well proved, it fits in too well with a thousand experiments and analyses, to be anything else. And here let us take the opportunity, before we go any further, of asking ourselves whether in that case we must believe all that the disciples of Freud ever tell us.

The short answer to that is a very definite "No!"

And that for two reasons. Firstly, there are always on the fringe of a new science many people who are attracted and interested but who, not to put too fine a point on it, have not sufficient intellect to cope with it. Beware of the person who is educated above his (or her) intelligence! Such people talk nonsense with the vocabulary of the wise. There are many such in the realm of psychology. But secondly, the wise, where a new science, and an inexact and difficult and immaterial science, is concerned, will not always be right either. It is not easy to be truly scientific—not to load your findings, that is to say, to make them weigh down in favour of what you *want* to prove.

You will, for instance, have heard no doubt of the Oedipus Complex, so called from a Greek legend (on which Sophocles based his most famous tragedy) wherein the hero unwittingly both kills his father and incestuously marries his mother. Those boys who suffer from this complex are so tied to a love of their mother that *unconsciously* they are passionately and even murderously jealous of their father. Now the Freudians are inclined to see that everywhere; they make it explain, one might almost say, half modern conduct and more than half the tabus and customs of primitive society. They *may* be right. Again, Freud is accused of harping too much on sex. That is partly due to misapprehension; when he talks about *libido* he means something wider than the crude sexual instinct. There is another great psychologist, Alfred Adler (*d.* 1937), who would say rather that our great instinctive, unconscious urge is not for sexual domination but for domination generally, for power, for self-expression. When we think of the man-animal's long childhood, where much is of necessity repression, when we remember the difficult childhood of his race, that urge for self-expression seems a natural one. On the other hand when we remember how fundamental is sex, and how concerned was primitive society with propagation and fecundity, we can begin to realize that Freud is not likely to be wholly wrong.

Obviously he was not wholly wrong. There was a great outcry against his teachings—just as there was against Darwin's—because it seemed to show up Man in so disgusting a light. Perhaps that very opposition has sometimes forced his followers to unwarranted extremes. What are we to do about it then, if we cannot believe all that psychology tells us? The answer is not easy: it is no more than to say that we must exercise our own judgment and to realize that we are dealing with a new and developing science. Freud's and Adler's views may some day be reconciled. And no one with any reasonable degree of intelligence need be hoodwinked by any pseudo intellectual who mouths a lot of nonsense about complexes, fixations, phobias, repres-repressions and the rest.

We can at least lay hold of the idea of an unconscious urge, an urge for power and self-expression and often manifested as sex. But where do we go from there?

Let us get hold of this idea: that any organization of life on anything like a civilized basis must entail a great number of restraints upon the conduct of the individual. The individual as a consequence develops standards of conduct which he observes. He develops a conscience. But those primal, crude desires for self-expression, and the exercise of power, and the imposition of his will over external nature and other human beings, are all still there. If society is to survive, those crude desires must be *repressed* and *sublimated* into something gentler and beneficial rather than harmful. That is what has happened; the struggle to make that happen, and to go on happening increasingly, might be said to be the epitome of history.

We have, then, crude desires and ambitions, of necessity repressed and pushed down into the Unconscious. Thence they emerge, harmlessly in dreams. That, if we were all perfectly healthy and happy in our minds, would be all there was to it. But, unfortunately, in varying degrees we are not.

This brings in the curative or what is called pathological side of analytical psychology. If there has been too much repression and inhibition, especially in our youth, or if there has been some shock to our mind or unhappy occurrence which we would like to forget and which therefore the Unconscious does its best to cover up, then "complexes" will be formed. A complex may be described roughly as a too-much-bottled-up repression, something that worries our mind and warps our conduct. The psycho-analyst will get us to tell him our dreams, or our half-waking thought, or notice what slips of the tongue we make or what word and idea we associate with another or avoid associating with another. He may even study our minds under hypnotism. He will seek to discover what, by torturous symbolism, our Unconscious is trying to hide. And in dragging it all into the light of day he may relieve us and rid us of our complexes.

The diseases and stresses and weaknesses of the mind are a fascinating subject. *Neurasthenia*, and its opposite *hysteria*; *paranoia* or thinking you are somebody great; our old friend *schizo-phrenia* or split personality: all these can have the most amazing manifestations—and can often, through skill and understanding and sympathy, be cured. But that is all the specialist's job; what we need to learn from a sketchy survey of the subject is something wider, an understanding, if we can achieve it, of how the normal mind works and of everyday human motives.

Motives. That is where particularly this new psychology has taught us something: that the urges and well-springs of human motive are not half so simple or so eminently reasonable as a comfortable nineteenth century would have had us believe. There is always that primitive bugbear, the Unconscious, to bedevil us.

Let us, then, finish this chapter on the human mind by taking two more of the all too many technical terms which the psychologist invents; and let us try to explain them and so in the process perhaps light up a little this business of human motives. The two technical terms are *rationalizing* and *the Persona.*

Rationalizing is finding a "good" reason for doing what one *wants* to do. The word *good* is in inverted commas, because it is only what we *call* a good reason. It is in fact a bad reason, a specious reason, an excuse. The whole process is in fact a dishonest use of our reasoning powers. We hoodwink both ourselves and others. The *real* reason for our conduct is some instinctive, some unreasoning, subconscious urge. But to acknowledge that to ourselves would be damaging to our self-esteem. We therefore invent these "good" reasons for doing what our whole *character*, one might say, is forcing us irrevocably and irresistibly to do.

We all rationalize at times, the worst and the best of us, from the dear old buffer, retired shall we say, who tries to show his importance by keeping away from a jolly party because he simply *must* do this. that, or the other, to the murderer who persuades himself that his victim is a blot on the landscape and his deed a blessing to humanity. We do it because we like to paint, both for our own benefit and the benefit of others, a better, a more reasonable, admirable, moral picture of ourselves than the real self ever is.

And this brings us to the idea of *Persona*, a word invented by the psychologist Jung to mean just this higher, more moral self which we try to impose upon ourselves and others as the real thing. Freud has christened something of the same idea "the Super Ego".

It is not necessarily a bad thing or a specious thing that we do this. It is really rather a necessity. Man somehow cannot live without at least some shreds of a good opinion of himself. Man, too, as we have said, has had to develop a conscience as he became civilized. But the "old Adam", the instincts and primal urges, the wilful desires to impose his personality, are all still there. We are, in fact, all of us to that extent double personalities, the Ego and the Super Ego, the real self and the *Persona*. At the best this can lead to the utmost saintliness and sublimation; at the worst it can lead to gross self-deception; to the bore, the complaining and misunderstood sufferer, even to the schizo-phrenic madman. And—to bring in finally two more terms—it is probably more often the "introvert", the type whose mind is naturally introspective and turned in upon itself, than his opposite, the more easy-going "extrovert", who will suffer from the eternal struggle between the real self and the ideal.

Let us leave it at that. Modern biology, anthropology, psychology have given us a totally different picture of man's origin and mind from any which could have possibly been guessed at by the best educated person of three or four generations ago. It is not always a pretty picture that has been revealed; but it is not a depressing one. Man's mind is subtle not simple, difficult but certainly not dull, still instinct-ridden but yet infinitely imaginative. And we shall surely do better with it if we know and understand it.

BOOKS: *Anthropology*, by R. R. Marett (Home University Library), is a good introduction to that subject. If you are really interested you will read Sir James Frazer's *The Golden Bough* (the abridged one-volume edition, Macmillan). Even that will take you some time but you will have a different outlook, you will be a slightly different person, when you have finished.

The full and very clear chapters on psychology in Wells' and

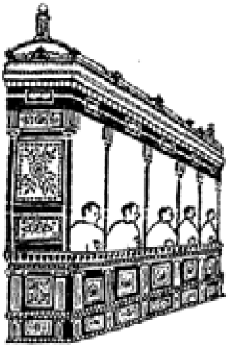
Huxley's *The Science of Life* are about the best introduction it is possible to find to that subject. Freud's *Interpretation of Dreams* (Allen & Unwin) is not a difficult book, though it may be a startling one. The idea of "rationalizing" is developed in *Mind in the Making*, by James Harvey Robinson (Cape).

There is a most thought-provoking book, *A Land*, by Jacquetta Hawker (Cresset Press). It tells the story of the "creation of Britain" and could equally be recommended after the chapters on Geology or Archaeology. It is mentioned here because it stresses the importance of *consciousness* in life and the evolutionary story.

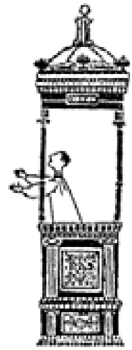
A Warning: there are books and magazines which use the word Psychology but talk rather about health and personality and how-to-get-on; they may be very good but they are not psychology as the serious scientist understands psychology.

PART THREE

Man's Achievements or His Influence on His Environment



CHAPTER X



MAN THE TALKER

(Grammar and the Use of Language)

WITH *Man's Achievements* we come to the Arts.

But obviously "achievements" will cover not only the Arts. We shall find ourselves drifting back to the Sciences, and for that matter wandering between the two—there is, we repeat, no fast line dividing the one from the other.

We must first ask ourselves: just what do we mean by the Arts? Perhaps it will help if we try first to answer the question, what do we mean by an Artist?

"Oh, of course he's an artist at the job!" we say airily. We mean that he does the job supremely well. We mean that he has done it with something more than mere cold efficiency, that he has within him, and has put into it, that little something extra that the other fellow hasn't got (and never will have, incidentally, however hard you stuff him with the science and the "know-how" of the thing). It is skill, *plus*. It is a matter of the spirit.

Very often, too, in speaking of an artist we mean someone who is affecting us in a way which cannot be explained in hard scientific terms. He is appealing to our emotions and not our understanding. Again it is a matter of the spirit.

Science is knowledge, facts. Art is the product of Man in action—Man who has that subtle, queer and amazing brain, who has imagination, who can create and appreciate beauty, who has wit and humour.

Not that to be funny is to be an artist. But let us always at least be reasonably light-hearted and not too deadly serious in our search for education. Education, obviously, is not just *knowing*. It is being able to appreciate; it is the widening of one's powers of understanding, of one's own skill, so that one blossoms out—we can at least devoutly hope!—from a mere closed and embryonic bud to a flower, open and sensitive, from a clod to a civilized being.

Of course we need science and knowledge; do not be swayed to the other extreme and scorn science, or believe that there is a horrible divorce and antagonism between Science and Art. But at least in these ensuing chapters we may for a while be able to leave exact definitions and hard dull facts. We are in the realms where people strive for beauty, where people achieve effects, where people respond with a thrill and are overcome with emotion. Our approach will certainly be different. . . .

It is of course all too easy to become "arty". But then it is equally easy to be too scientific, that is to say too narrowly scientific.

There is a type of second-rate mind, steeped in scientific method, which seeks to prove by fantastically laborious experiment what is already intuitively obvious to any really lively and sensitive natural intelligence. There is the type of pseudo-scientific mind which shuts itself from half of life because it will have nothing to do with anything that cannot be *proved*. Such a one needs perhaps a large dose of G. K. Chesterton, who has said that there is as much mental deficiency in not being able to believe anything that cannot be proved as in accepting anything with extreme gullibility. And then perhaps those people who want to leave all faith and imagination and intuition and fancifulness out of the picture are not even being truly scientific. Perhaps they are leaving out a good deal that has lately been learnt of the nature of man. Remember what biology and anthropology and early history have taught us: that the successful type in the evolutionary race was the animal with the big brain and—to use an unscientific term—the big heart; that man struggled towards mastery by the exercise of his imagination. "Sensitive awareness" one writer* has christened this attribute that has won the human race success. That does not fit in well with a worship of facts and science and a suspicious dread of the arts and graces and the fancifulness of men's minds.

In our last chapter we have already hinted that primitive man was himself remarkably fanciful in the way he used his budding mind, and particularly in the way he told himself myths and stories of his heroes and gods. With speech came, perhaps inevitably, story-telling. From that, in due course, came the art of literature. It behoves us, then, to look somewhat closely into this business of language and the use of words. For a while we become almost scientific again. . . .

* Gerald Heard: *The Emergence of Man.*

There is a book called *The Miraculous Birth of Language.* Indeed there are many books speculating on just how speech began and developed. The trouble is that it is mostly speculation; nobody can ever really know. An interesting speculation nevertheless: why did not language grow up the same everywhere; how did the *rules* of language grow up; were primitive languages more, or less, complicated than our own? We may not be able to answer these questions here*; but we can at least use the "historical" approach, which is the modern grammarian's method and certainly the more interesting.

The first thing to be done is to get across to ourselves the idea that language is something that should very much *not* be taken for granted. It is in itself a miracle—that is no hyperbole. In our sketch of evolution and history we have already suggested that it is the greatest achievement that divides man from animal. But like all great things it has its dangers. The danger is, to imagine that it is a *perfect* instrument of the mind. It is very far from perfect. From one aspect alone, it would only begin to be perfect if what we meant by a word was exactly what all our listeners always understood by that word. And that obviously is not so: we have but to recall at the moment how different a thing is conjured up by Communist and Capitalist at mention of the word *Democracy*. The trouble is that many other differences are not so obvious. Yet they are there; and we forget all too easily that they are there.

We are straying into what is sometimes called the science of *Semantics*, or the study of meaning, a little more about which will be said in the last chapter of this book. Let it suffice at the moment that language and meaning are something to be treated with circumspection and care—and not on the easy assumption that all the thousands of abstract words we have invented can be thrown about carelessly, and with impunity. Words, in fact, are too important to be used irresponsibly.

We come back to the idea that we humans have a mind which is not just a reasoning machine. Words have an *emotional* appeal as well as a rational one: that is half their danger and half their power. That lets in the poet, and the demagogue.

We are going to be respectful about words, then; almost worshipful. Let us get back now to the ideas of language and grammar.

Of all the subjects taught at school, perhaps we find *Grammar* the dullest. Parts of speech; subject and predicate; cases and persons and tenses, conjugations and declensions: how we hated them all,

* But Otto Jasperson can—and does—in his book *Language, Its Nature, Development and Origin* (Allen & Unwin), in particular the last chapter.

how many of us probably still hate them! Listen to this, then, from a modern book designed to help you to learn foreign languages and to teach you something about your own as a necessary preliminary. It is from the *Loom of Language*, by Frederick Bodmer, and he is not at all polite to the old-fashioned grammarians.

> "The rules embodied in these conjugations and declensions" (he says, talking about grammatical rules in general) "tell you much you need to know in order to translate classical (i.e. Latin and Greek) authors with the help of a dictionary. Grammarians who have spent their lives in learning them, and using them, carried over the same trick into the teaching of languages of a different type. They ransacked the literature of living languages to find examples of similarities which they could also arrange in systems and declensions and conjugations, and they did so without regard to whether we really need to know them, or if so, in what circumstances."

Or listen to Otto Jesperson, probably the greatest living exponent of grammar:

> "Language is nothing but a set of human habits, the purpose of which is to give expression to thoughts and feelings, and especially to impart them to others. As with other habits it is not to be expected that they should be perfectly consistent."

All that may cheer us. But do not let us take too big a swing with the pendulum; do not let us think that all grammar is unnecessary and all its rules absurd. They are not. All we need to do is to avoid the grammarian—professional or amateur—who is dull, dreary, involved, inflexible and pedantic. How often have we heard—and perhaps been guilty of ourselves prolonging—long sterile arguments as to whether a word or phrase, or its use, is "correct"! How often the sensible comment should have been: "there is no absolute rule; the real criterion is whether the speaker or writer is making himself as clear and understandable as possible!" It is indeed the old story: tools are made for men, not men for their tools.

We have already called language a tool or instrument. We can call it also, to change the metaphor, the vehicle of thought. And so grammar may be described variously as the *table manners* of using the implements of language or as the *traffic rules* for the vehicle of thought.

These two somewhat fanciful titles correspond to the two main divisions of grammar: *accidence* and *syntax*.

Accidence is the same word, more or less, as accidents. It is what befalls or happens to a word as we use it for our convenience: in other words its inflexions. Our genitive or possessive case, the "apostrophe *s*", is an inflexion. The added "s" for the third person, "he love*s*", is another, and the past tense, the ending "-ed", another.

Now these are *conveniences*—obviously. It would be possible to have a separate word for every plural, every case, every tense and mood of a verb. In which circumstance one might say there would be no such thing as grammar. Indeed one might go further and say that as one picks up one's own language as a child every inflected word is virtually a new word, and that therefore there is no need for grammar. But think what sized dictionary one would have to have! And unfortunately one does *not* learn automatically to speak—much less to write—with perfection. If one is to be taught therefore, there must be definitions, and there can be rules which help. Grammar in fact has two great uses: to help us learn another language, and to enable us to consider and discuss and become more expert in the use of our own.

Accidence or inflexions, then, are the way words are manipulated —as a sensible substitute for inventing totally new words—to express different aspects of meaning and to avoid ambiguity and misunderstanding. Now the way the modern grammarian sets about teaching them is, as we have said, historically, that is to say from the point of view of their evolution. Take, then, such a simple thing as the formation of plurals. The old-fashioned grammarian would cite "adding *s*" as the rule, and would give long strings of words such as *oxen* as "exceptions". Nowadays we should point out that oxen is an Old English or Saxon word and that what now seems something of an exception to us was once just as much a "rule" as is the adding of "s".

The historical approach will shows us some more interesting things about accidence.

It will show a surprising fact: that as we go back to the more primitive languages we find that they get not less complicated but more. Yet when we begin to think, perhaps that is not so surprising. When men were struggling to create really comprehensible speech, the task of *building up a sentence* must have been very difficult. Perhaps sometimes they built up not so much sentences as most highly inflected and complicated words. Whatever the process, however, the fact remains that they overdid it! Take Latin, which is a much more primitive language than modern English, and therefore much more highly inflected. You change the noun if it happens to be the object as opposed to the subject of the verb: *mensa*, a table; but I hit the table—*mensam*. You even have a "vocative" case: Brutus, the name; but *Brute* (Bru*tay*) if you are addressing him. (That is perhaps more intelligible if you think of the analogy of nicknames: his name is Frank but you call him Frankie.)

But Latin and most early (and some later) languages go even much further than that. Gender, for instance, will not tie up with reality: not simply male and female and neuter, but all or most inanimate things either masculine and feminine (as we still call a ship "she"). Think, here, of what we said of animism in the chapter on Anthropology and see if you discern any significance and connection there.

And then, the adjective has to inflect itself to agree with its noun in case and gender: that table that we hit, *albam mensam*; but white Brutus (if he was—Caesar didn't think so), *albus Brutus*. Why all this fuss, we ask now; how does it make it clearer? The answer is, quite simply: it doesn't, at least not enough to make it worth while. We don't *need* all these inflexions.

Sometimes we get rid of the useless ones; we have done so in our own language for instance, for Old English had very many. Conquests and invasions help this sort of process: one can rightly imagine, for instance, our Norman invaders having little use for the difficult and queer English inflexions—they made fun of them, though no doubt there were a few of their own just as funny—and at the same time the native, when talking to the Norman, would perhaps selfconsciously and apologetically slur them over.

But sometimes in the modernizing process we have not been quite so clever. There is evidence to show that the inflexions of many verbs are really the pronouns tacked on at the end. In Latin am*o* equals I love; ama*t*, he loves, and am*amus*, we love. But then along comes French (the conquered Gauls picking up their victor's tongue) and puts its own pronoun in front as well as keeping the inflexion: *J'*aim*e*, and *nous* aim*ons*.

So you see that we cannot expect the accidence of a language to be perfect or perfectly streamlined. A language is something rather like the human body, a masterpiece yet something not quite reasonable, not quite what you would plan if you started afresh, not free from such vestigal absurdities as the vermiform appendix. For, like our body, it too has evolved, and *is alive*. Language is a living thing: rules are helpful for understanding it and analysing it; but those rules should be kept as few as possible, and they are not unbreakable.

But what about Syntax, the "traffic rules", the building up of sentences?

Most books on grammar will begin syntax by talking about "Parts of Speech"—which is in any case a term of unhappy memory to most of us. We must again be careful not to react too violently against the old-fashioned grammarian. Nevertheless, in our search for an understanding of language, it is probably true to say that of the two alternatives, to be hag-ridden by "parts of speech" or to know nothing about them at all, the latter is infinitely preferable. Remember:

(*a*) Word classification is again a *convenience* only; and

(*b*) A single word can be so many different parts of speech depending on its context, that often its exact definition is only of academic interest and a trap for waste of effort and argument. (To take an extreme sort of example, the word *but* we think of as a conjunction. But what about the Shakespearian "But me no buts!"?—it has been made into both a verb and a noun!)

Indeed, it is not a bad idea to follow the plan of a book we have mentioned already, *The Loom of Language*, and, having marked off Noun, Pronoun, Verb, Adjective, to lump the rest together as "Particles", or as one might almost say, "bits and pieces". But one must then remind oneself at once that these bits and pieces occur extremely frequently in any language and often have a very idiomatic use. Particularly is this so of those prepositions which we may call "directives", words such as *in*, *at*, *to*, *on*, *up*, *off*, *under*, *through*, *out*. Between any two languages there will be no single set way of translating such words; each language will use them in different ways on different occasions. Listen to any foreigner talking and see how often he goes wrong with such words.

Not that we can afford to wander off too far into the subject of learning foreign languages. We will however at least stress the fact that it will help greatly in learning another language to know a good deal about the structure of your own (at the least it will enable you to use the dictionary more intelligently), and the equally important fact that having to learn another language will help you to appreciate the idiosyncrasies, the habits, the finer uses, the advantages and disadvantages, of your own.

But we are not really getting down to syntax. We must face up to the truth: there is no short cut to the subject, there is no way of giving a potted edition of it. Dependent clauses, preterites and gerundives: such as these you must either learn about in detail or leave alone. And the best simple piece of advice on the subject is surely this: leave them alone unless there is some—one or more—construction or grammatical term that has always worried you, that in fact you have an inferiority complex about; and if there is such, then go straight to a book on grammar—there are suggestions at the end of this chapter—and achieve understanding once and for all. You will probably find it is all far simpler than you had imagined.

For the rest, let syntax and grammar be absorbed in the much wider and more interesting subject of how to write, or rather how to express oneself, well—how to take good advantage in fact of Man's two tremendous inventions, speech and the written alphabet.

There was once a Cambridge professor, holding the Chair of English Literature, who perhaps rather surprised his listeners by exhorting them in his opening series of lectures to practise *themselves* the art of writing. That professor—not to make a mystery of it—was Sir Arthur Quiller-Couch, better known and to a wider public as "Q", the novelist. The lectures were delivered in 1913, were printed as *The Art of Writing* in 1916, and have been reprinted at intervals ever since.

Why did Q so impress on his students of literature the need to practise the art of writing themselves, and why do we bring this to your notice here? To answer the second question first, we want to shift the ground for a while to the *appreciation* of literature and good writing—practical appreciation and not academic. For two complementary and balancing truths arise: first, that it will help you to enjoy good literature if you know a little about the practical problems involved in making it, and secondly—which is the immediate point at issue—that the best way to learn to write is to study intelligently those who have done it well.

Quiller-Couch's immediate concern, in those lectures of a generation ago, was to get out of the heads of his hearers the idea that, to study a piece of literature, you took not the book itself but, rather, a lot of books *about* it, books that explained it and analysed it and pulled the unhappy things to shreds for you—"a swarm of little schoolbooks," Q told them, "pullulates annually, all upside down and wrong from beginning to end." The reason for those, he insisted gently, was that that sort of thing was so much easier to *examine* upon. And although we do not now suffer quite so much, surely that complaint raises a responsive echo in us today. . . .

No! said Q. In studying any great piece of literature, study it *whole*, take it "absolutely", try to find out what the author's mind intended and let him get across to you what he meant to get across. You are studying a work of art, not something to be dissected and analysed for you like a specimen in a science laboratory—a work of art "the success of which depends on the author's skill to give as on ours to receive". And surely our skill to receive will be enhanced if we can recognize, *because in our own small way we have tried our hand at the game*, the author's skill to give. You like watching a cricket match better if you are some good at cricket. . . .

. . . . .

But all that is rather difficult. Before coming down to practical advice on the use of words, let us put something of what we have just said on a much lower plane. It is this: no one should be allowed to write, or indeed one might say to talk, unless he can at least express himself with clarity and interest. And how many books and text-books and articles and papers and lectures by scientists and others have sinned on that score; how many talks, discussions, committee meetings are quite worthless and an infinite bore! Read, and listen (to yourself included) critically; and be both humble and thoughtful about it.

The first need is to appreciate the difference between speaking and writing. To be able both to talk well and to write well there is needed a command of vocabulary and at the least an elementary knowledge of grammar, even though such knowledge may have been picked up unconsciously in the course of a reasonably good education. Beyond that, most of the sins of *talking* are psychological—sometimes pathological. It is a matter of mental discipline, of not allowing one's words and thoughts to dribble out (or pour forth) merely connected by idle association of ideas. Sometimes it is simply a matter of sensitive awareness of the listener's reactions, a realization that he or she does not really need to be told a thing three or four times in slightly different ways and is becoming a little restive and bored. We shall have achieved something at least if we realize that it needs a real effort to avoid these sins, and that one does not become even a passable user of the spoken word automatically. And that is a lesson that is very little taught in schools.

Writing has both advantages and disadvantages compared with speaking. In speaking one has the advantage of pause and emphasis, of tone and pitch and modulation of voice—of expressive hands and face too if one is so gifted. In writing one loses all this. But on the other hand one has time to think, and opportunity to go back and revise. The telling and felicitous phrases can be sought for and achieved; the more complicated sentence can be thought out and still remain clear and intelligible. We invent punctuation to make up for the lost expressiveness of the voice, though that does not go all the way. To take an extreme example, if we write "I tell you that that 'that' that that man spoke", etcetera, it needs, even with inverted commas and so forth, a little thought before its meaning is clear; say it, and there is no difficulty at all. We use the colloquialisms "as" for "because" (I left early, as I had a train to catch), or "so" for "so that" or "therefore" and in speech we get away with it. But in writing we expect something better and less ambiguous.

However, in this advantage of writing, that it can take time to elaborate and improve itself, lies a most terrible danger. For how many people seem to think that writing is so wonderfully and fearfully different from speech that there is a bounden duty on their part to produce something so involved, so stilted, so prolix and unnatural, that the whole thing is utterly incomprehensible and only fit for rapid and immediate interment in the dustbin! They have got it all wrong. Just because of that lack of help from the expressive voice, *writing has need to be so much the more clear and succinct.* True that the longer and more complicated sentence can be thought out; but what is the gain if it has become virtually incomprehensible in the process?

What these people who tie themselves and their readers in a tangle of words are really doing is to try to run before they can walk. They are seeking to achieve brilliant writing before they can produce understandable writing. They may never achieve brilliance—that is something of a gift. But they can at least train themselves to be direct and intelligible. Certainly brilliant and telling prose was never written by anyone who had not first disciplined himself to achieve lucidity.

These, it has been said, are the essentials of good writing. One must strive to be:

Direct
Simple
Brief
Lucid
Vigorous.

The double negative ("not inconsiderable" for "considerable") is not direct, it is usually merely timid. "It would thus appear that" is not so brief as "apparently" and gets you no further. "In the contemplated eventuality" means no more than "if so", and is neither so simple nor so lucid. *Pomposity* in fact, which so many mistake for good writing, is the very reverse of it. As for being "vigorous", that is more difficult. We will come back to that.

It has been sometimes said that all of the first four of these five aims can largely be achieved by always preferring in one's writing the Anglo-Saxon word to the Latin. That is an exaggeration, and rather a dangerous one at that. But there is something in it. We need for a few paragraphs to consider our own particular language.

No doubt we all get tired of being told by enthusiasts that English is a wonderful and unique language and that we ought to think ourselves lucky to be able to use it. We therefore discount this. Or disbelieve it. And this is a great pity, because it happens to be very true.

Joseph Conrad, the novelist, was a Pole. The story is told of how he once passed a field of cabbages, the sort that have an effect when growing together of being more blue than green. He looked at them with appreciation. There was only one epithet to describe them, he said, and that was French: *bleu foncé*. Which was a pity, from his point of view. For in spite of that, indeed in spite of a good deal more, he decided after much thought to write, not in his native Polish, not even in French, but in English. He considered that it gave him more scope.

English is largely the result of two quite separate languages, Anglo-Saxon and Latin (through French). When the Normans came they did not kill Anglo-Saxon. They left the common people to talk it. Gradually, by a lucky chance, the two blended. Both languages went through a difficult period—and then suddenly blossomed, rather like somebody whose illness "really seems to have done him good". Caxton (who lived in the fifteenth century), more than merely the first English printer, was in the really extraordinary position of being able in the books he translated and published to choose and invent his language (and his spelling) as he went along. There followed soon the writers of the Shakespearian age—drunk with words.

The Latin word is usually longer and more pompous and more dignified, the Saxon word more often short and simple. There is, too, the advantage that often the two show a useful shade, or more than shade, of difference in meaning. A walk is a walk; but a *perambulation* can be used to suggest something altogether more portentous. Take the word "portentous" itself. To portend has a different meaning from foreshadow, its Anglo-Saxon translation. Both words are useful.

Words of Latin root can make prose sonorous, majestic and dignified. But on the other hand we should lose a very great deal if we had not our short simple words. The English Bible is their great exponent. Open its very first page.

> "In the beginning God created the heaven and the earth.
>
> "And the earth was without form, and void; and darkness was upon the face of the deep. And the spirit of God moved upon the face of the waters.
>
> "And God said, Let there be light: and there was light."

Short words can have a memorable simplicity. They can create a terrific effect.

The fact remains however that if you care to analyse almost any piece of writing, or piece of conversation, there will be more words used of a Latin origin than an Anglo-Saxon. There will be a fair number of Greek words too—increasingly so as scientific terms are multiplied and seep into general use. Have we got to learn Latin and Greek, then —"the Classics"? Hardly so!

For it is reasonably accurate to say that the Classics are taught to the young for three useful purposes: to help in learning one's own language; as an exercise for the growing mind; and—if one gets far enough—to appreciate the classical masterpieces in the original. And often there is a falling between two stools, because enough progress is never made to achieve the third purpose and much more time than necessary is spent if nothing so ambitious as that third purpose was ever intended. The grown-up, then, unless he is attracted towards becoming a classical scholar—a very attractive thing to be, admittedly—need surely concentrate only on the first purpose: a help in learning one's own language.

So much for our digression on our own language and the learning of the Classics. We return to the reason for that advice to prefer the Saxon word in one's writing to the Latin.

The reason is partly because of that fatal tendency of the tyro or the ignorant to indulge in a needless pomposity in the fond belief that he is creating fine writing. That sort of person will gravitate to the long Latin word as does mud to the bottom of a pond.

But there is more to it than that. Where there are Saxon and Latin equivalents in our language the first is almost always the concrete thing and the second the abstract derived from it. And abstract words can tend so easily to be nebulous and woolly and even, in bad hands, practically meaningless. There arrives what is usually called *jargon*: pretentious stuff whose ugliness is only exceeded by its lack of meaning. As somebody has asked, would anything have happened if Churchill had said, "Donate us the implements and we shall finalize the assignment!" and not "Give us the tools and we will finish the job!"? To compare the two word for word is a very good lesson in what not to write.* Jargon and officialese can even go further and Latinize a Latin word unnecessarily: transportation for transport, for instance.

However, do not of course run away with the idea that abstract words should always be avoided if possible. It is rather that abstract words are a danger and should be used with care because their meaning, being *derived*, is so much less exactly defined than concrete words. For the derivation of an abstract word, when it can be traced, is found to bring us back almost invariably to a concrete word. *Ferocious* brings us back to the Latin *ferus*, a beast; *cupidity* means originally lustfulness rather than greed, and we come back to Cupid, the god of love; and so on.

* The question was asked by Henry Strauss in a review of a book intended primarily for erring Civil Servants but not below the notice of others: *Plain Words*, by Sir Ernest Gowers, published by the Stationery Office for two shillings. There is also a sequel, *A B C of Plain Words*.

All these abstract words are in fact *metaphors*. (And when you come to think of it, how better to invent an abstract word than by using a concrete one metaphorically? Primitive man must have had a lot of trouble in inventing abstract and generalized words—someone discovered a tribe who had a word for every *kind* of tree but not a word for tree.) Metaphors abound in any language much more than one would at first imagine. When you talk about a *leaf* of a book you are speaking metaphorically: it is a piece of paper thin like the leaf of a tree. To speak of the *head* of a deputation or a list or a form is again to speak metaphorically: there is only one real head, the thing on your shoulders.

These we call "dead" metaphors, because the likeness, the connection, has ceased ever to occur to us when we use them. That is not to say that we should avoid using them; we cannot possibly do so. What we should avoid, rather, is the half-dead metaphor, one that was originally brilliant or striking but which is already tarnished and trite and would be better thought out anew. *Flaxen* as applied to hair is perhaps an example. How many people nowadays ever see flax? The person who invented *platinum blonde* was at least thinking for himself anew. There are a host of metaphors, and similes too, connected with horses: "spur him on", "let him have his head" and so forth. A more live writing might think things out afresh with a more modern idiom—slang, incidentally, is often the first to do it for us: "step on it", "going all out".

And for "live writing" we might substitute "vigorous writing", and so get back to the fifth of the essentials listed a few pages earlier. Perhaps we begin to see how, and only how, that *vigour* can be achieved: by thinking for yourself as you write and not falling back, through unconscious laziness, upon those thousands of little group-packets of words, once so live, that have died long ago, and so are already tarnished, and pulped, and bludgeoned into *clichés*.

Finally let us review shortly one other set of rules for good writing: they are less simple and obvious, and will bring us conveniently round to the next chapter, which is the appreciation of literature.

They are Q's again; and they are these. In all your writing, strive to be:

Appropriate
Perspicuous
Accurate
Persuasive.

Those need some thinking about and explaining, although the middle two are fairly easy. Of *perspicuity*, Quiller-Couch needs to say little more than that one's aim in using words *is*, after all, to be understood! He adds that the more clearly you write, not only the more clearly will you be understood but the more clearly will you understand yourself.

On *accuracy* he appeals to our pride of race, that is to say, the Human Race. He becomes, this professor of English, mildly biological. The opposite of accuracy, he says, is slovenliness, both of writing and speech. And who wants to be that? "After all, what are the chief differentiae between man and the brute creation but that he clothes himself, that he cooks his food, that he uses articulate speech? Let us cherish and improve all these distinctions."

To help explain *appropriate*, he turns it into a noun, "propriety" or "observing the occasion".

"When you talk or write," he says, "you should wish to *observe the occasion*; to say what you have to say without impertinence or ill-timed excess. You would not harangue a drawing-room or a subcommittee, or be facetious at a funeral, or play the skeleton at a banquet; for in all such conduct you would be mixing up things that differ."

We have in fact come upon *style* in writing, that rather difficult, dangerous word. For if we do not like what we read—for more reason than that it is merely unclear and ununderstandable—is it not that the way (or the "style") in which it is written offends us because it has *struck a wrong note*? Is it not because it has striven after effect and failed, has been painfully facetious perhaps where facetiousness is out of place, has affected a grand manner where the matter has signally failed to be grand?

Nor is to avoid all these pitfalls too easy. We are approaching the positive and leaving the negative now: not what the tyro must try not to do, but what the great writer does achieve. One more quotation:

"The perfection of style is variety in unity, freedom, ease, clearness, the power of saying anything, and of striking any note in the scale of human feelings, without impropriety."

That same phrase again at the end, "without impropriety". . . .

Style, as so many people have said, and so many other people have forgotten, is not something laid on afterwards. If you want to write a scientific treatise (or anything else for that matter) and it comes out unclear and uninteresting, you will not better it by adding frills; you will make it worse. Style, it has been said, is a "thinking out into language". It is "a deft use of words".

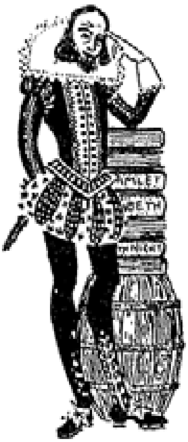
Which brings us to *persuasiveness*. This is what Sir Arthur Quiller-Couch said to his bygone generation of students—and it will be absorbed, if they have any sense, by many a succeeding generation:

"Let me revert to our list of the qualities necessary to good writing, and come to the last—Persuasiveness; of which you may say, indeed, that it embraces the whole—not only the qualities of propriety, perspicacity, accuracy, we have been considering, but many another, such as harmony, order, sublimity, beauty of diction; all in short that—writing being an art not a science, and therefore so personal a thing—may be summed up under the word *Charm*. Who at any rate does not seek after Persuasion? It is the aim of all the arts, and, I suppose, of all exposition and the sciences; nay, of all useful exchange of converse in our daily life. It is what Velasquez attempts in a picture, Euclid in a proposition, the Prime Minister at the Treasury box, the journalist in a leading article, our Vicar in his sermon. Persuasion, as Matthew Arnold once said, is the only true intellectual process. . . . Nor can I imagine an earthly gift more covetable by you, Gentlemen, than that of persuading your fellows to listen to your views and attend to what you have at heart."

Whereupon the gentle author-professor no doubt surprised his audience once more, by pleading with them to practise the art of writing *verse*. For, said he, that supreme aim of writing, Persuasion, can only come to full achievement where there is an appreciation and a sense of *beauty*.

Which brings us to the next chapter.

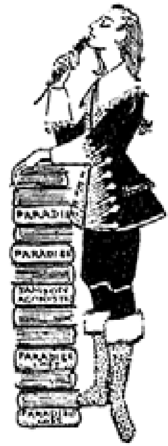
BOOKS: For simple direct answers to difficulties about grammar, go to such an orthodox and well-indexed primer as the *Manual of English Grammar and Composition*, by J. C. Nesfield (MacMillan). Fowler's *King's English* (O.U.P.) is the recognized book on how to use the English language correctly. Sir Arthur Quiller-Couch's *The Art of Writing* (Cambridge University Press) is delightful, even if some of the later chapters are difficult. *The World of Words*, by Eric Partridge (Hamish, Hamilton), popularizes Jesperson. Roget's *Thesaurus* (the Greek for "treasure"—i.e. of words) collects words into groups and gives their synonyms and antonyms: you will probably be getting hold of a copy if you really want to write. If you want to know something about the best way to tackle foreign languages, go to the book already referred to, *The Loom of Language*, by F. Bodmer (Allen & Unwin).



CHAPTER XI

MAN THE WEAVER OF WORDS

(Literature)



POETRY and "charm" and "a sense of beauty": that is where we have taken over from the last chapter. And for pity's sake let us avoid feeling suspicious or superior or scornful about it! To understand about literature and to appreciate how it achieves its effects is important and difficult. To acquire—and then not to lose—a liking for poetry is something very worth while.

What we need to appreciate as the next step is that extraordinary fact of the dual function of words. They make sense. And they stir emotions.

They stir the emotions mainly by two means: the artistry of the human voice, and the rhythm into which they are combined. That brings in *music*. It is believed that the beginning of speech came with the beginnings of song, or rather with the natural need and urge to sing —man after all is an animal with a fine throat and vocal chords worth playing upon. All that is at least a very reasonable supposition. We are on firmer ground when we say that the first literature was verse sung to music. The epics, the sagas, the Iliad and the Odyssey of Homer, were sung to the harp. *They had a rhythm imposed upon them by music.*

Those epics and sagas were also full of a direct, simple, heroic emotional appeal. That is verse, that is poetry: words keyed up to an emotional height. For music, which is to say metre and rhythm, makes those heights possible, it creates the right atmosphere. Just why it is so is perhaps impossible to say. But that is how humans are made, how they react.

If we are going to appreciate verse we need to appreciate very clearly the difference between poetry and prose. Poetry is "memorable speech set down in metre with strict rhythm". Prose is a record which, dispensing with metre, uses rhythm laxly and sparingly. Poetry is for the heights, and prose is for the long-sustained plains of literary travel. They each have their place and they certainly cannot be mixed—we come again to that "appropriateness" in style, of the previous chapter. The inversions and word orders and repetitions of verse, the great wealth of simile and metaphor, are out of place in prose. But on the other hand we do not always want to be at that pitch and key. That is perhaps why the long-sustained epic poem is the hardest to achieve with success and that as we have become more civilized, or at least more sophisticated and less simply heroic, the story has gradually left verse form for prose and the *novel* has arrived and apparently come to stay.

Rhyme is not necessary for poetry, obviously. It helps to point the rhythm, to achieve an effect; but it is not the only way. There was a phase of early English poetry when alliteration only was used.

Now what is the effect which poetry achieves? Surely it is that effect of being "memorable"—not merely something easy to remember but something you can't forget. Which, for instance, is more memorable, the longest and most careful treatise on the mutability of the flesh, or this single verse from Gray's *Elegy*:

> The boast of heraldry, the pomp of pow'r,
> And all that beauty, all that wealth e'er gave,
> Awaits alike th' inevitable hour,
> The paths of glory lead but to the grave.

Those are noble words. They strike through to the emotions—and they stay.

The poet feels deeply, and transmits his emotion. It may be great sadness: Charles Lamb's

> All, all are gone, the old familiar faces.

Or it may be great bitterness: Siegfried Sassoon's poems of the 1914/18 War. "The General" for instance:

> "Good-morning; good-morning!" the General said
> When we met him last week on our way to the Line.
> Now the soldiers he smiled at are most of 'em dead,
> And we're cursing his staff for incompetent swine.
> "He's a cheery old card," grunted Harry to Jack
> As they slogged up to Arras with rifle and pack.
>
> But he did for them both with his plan of attack.

In his "Soldiers are Dreamers All" sadness and bitterness come together. Here is the last verse:

> I see them in foul dug-outs, gnawed by rats,
> And in the ruined trenches, lashed with rain,
> Dreaming of things they did with balls and bats,
> And mocked by hopeless longing to regain
> Bank holidays, and picture shows, and spats,
> And going to the office in the train.

Julian Grenfell and Rupert Brooke saw beauty as well as horror in war. . . .

But turn from war to love. Sir Thomas Wyatt wrote this over four hundred years ago:

> And wilt thou leave me thus?
> Say nay, say nay, for shame!
> To save thee from the blame
> Of all my grief and grame.
> And wilt thou leave me thus?
> Say nay! say nay!

That is something simple and direct for you. And, you will notice, quite monosyllabic. It certainly is not prose; it is true poetry.

> O saw ye bonnie Lesley
> As she gaed o'er the border?
> She's gane, like Alexander,
> To spread her conquests farther.
>
> To see her is to love her,
> And love but her for ever;
> For nature made her what she is,
> And ne'er made sic anither!

Robbie Burns undoubtedly did love some others. But it was to our advantage as well as the girls'.

Robert Herrick loved often too. In "To Dianeme" he is gently reproving:

> Sweet, be not proud of those two eyes
> Which starlike sparkle in their skies;
> Nor be you proud, that you can see
> All hearts your captives; yours yet free:
> Be you not proud of that rich hair
> Which wantons with the love-sick air;

When as that ruby which you wear,
Sunk from the tip of your soft ear,
Will last to be a precious stone
When all your world of beauty's gone.

Walter de la Mare was kinder, if sadder, on the same theme. Here is his "An Epitaph":

Here lies a most beautiful lady,
Light of step and heart was she:
I think she was the most beautiful lady
That ever was in the West Country.
But beauty vanishes; beauty passes;
However rare, rare it be;
And when I crumble who shall remember
This lady of the West Country?

Let us go on quoting for a little longer....

Is your taste simple? Newbolt, then, with his "An' Dreamin' arl the time o' Plymouth Hoe" and "The Wistaria trailing in at the window wide". Tennyson's *Ulyssees*, "for lust of knowing what cannot be known . . ." Henley's "I thank whatever Gods there be for my unconquerable soul".

Do you like light verse? You might do worse—there is *An English Book of Light Verse*, published by MacMillan, and another by Faber. Remember Chesterton, with "The rolling English drunkard made the rolling English road", or the *Song of Dog Quoodle*, "They haven't got no noses, the fallen sons of Eve".

Some poems, one realizes, are read almost for the sound and the rhythm of the words alone; some poems we shall never fully understand. Nevertheless let us read and absorb them, and they will become for us a treasured possession. Lord Wavell, in his anthology *Other Men's Flowers*, confesses that Francis Thompson's *The Hound of Heaven*, by no means an easy poem, has had a special place in his life, and adds, "I have used the magic of its imagery in my times of stress, to distract my mind from peril or disaster." That is not a bad sort of example to follow....

Or take Blake's poem. Do we know *exactly* what this means:

When the stars threw down their spears
And water'd heaven with their tears.

But surely we read on—and it is memorable:

Did He smile His work to see?
Did He who made the lamb make thee?

Tiger, tiger, burning bright
In the forests of the night,
What immortal hand or eye
Dare frame thy fearful symmetry?

Poetry one reads with enjoyment—not trying too hard to like what one does not like. Poetry one reads with quietness and patience—not, as one reads one's scientific text-books, with fierce desire to tear the guts out of them and gulp down the benefit. Poetry is not absorbed like that, poetry is not utilitarian. Poetry, if you like—and to return for the last time to Quiller-Couch—is "Persuasion through Beauty". Relax then, and enjoy!

So much for poetry. The next point which we need to appreciate is one which applies to all literature. We have hinted at it already. It has been most simply put, but perhaps rather exaggeratedly and frighteningly put, as that "reading is as much an art as is writing".

What is meant is that in reading literature—that is to say, works of imagination and not of fact only—one must make some effort to respond to the mood and intention of the author. Virginia Woolf has said of this:

> "Do not dictate to your author; try to become him. Be his fellow-worker and accomplice. If you hang back, and reserve and criticize at first, you are preventing yourself from getting the fullest possible value from what you read. But if you open your mind as widely as possible, then signs and hints of almost imperceptible fineness, from the twist and turn of the first sentences, will bring you into the presence of a human being unlike any other."

Again, relax and enjoy! Give the book a chance, at least to start with! Which does not mean that one should relinquish all right to be critical later—or to throw the book aside if one thinks it is bad.

Nor for that matter should anyone advise you to struggle too far with a book which you know to be deemed good but which you cannot appreciate. Struggle for a while, yes! But force yourself too far, and you do more harm than good.

A word in fact now about being "well read", and about the Hundred Best Books and that sort of thing. Holbrook Jackson, who has written more books about books than most men, has said: "I believe that nothing is more likely to destroy an authentic gift for reading than undue insistence upon established masterpieces. . . . The only hundred best books is the hundred that is best for you." And Sir Desmond McCarthy, the great critic, has expressed the view, rather discouragingly perhaps, that unless one has started very young, one can never really become well read.

Let us give up the impossible, then, and in an effort both to become reasonably well educated and not to miss pleasures that are open to us, take a middle and a not too difficult course and avoid using as it were a mental forcible feeding-pump which will sicken us for life with just what we are trying to help ourselves enjoy.

Just what are we trying to help ourselves enjoy? We need to step back and recapitulate.

What does Literature include and what does it exclude? It is possible to divide literature neatly under subheads: *fiction*, *biography*, *travel*, and then somewhat in despair for what is left over, *belles lettres*. That may be useful for a bookshop; but it is worse than useless here, it is a trap and a menace. But do we exclude from literature such scientific treatises as Darwin's *Origin of Species*, Sir James Frazer's tremendous book on Anthropology, *The Golden Bough*, or Fabre's books on the life of insects? The answer is, Indeed no! Why? We are on delicate ground here. But surely it is because they are works of imagination as well as fact; *not* meaning here by "imagination" the reverse of fact, the opposite of truth, but that the author has with terrific effort put his mind and soul into the making of the book, has let his imagination play over the theme, has seen further, has put down more than dull unlit facts, and has given us that something more which is a work of art. That is all one can say. . . .

Now Literature is very often about *people*. Again why? The answer is, surely: because we are people ourselves and nothing interests us more; because human thought, human character and human conduct are all infinitely subtle, infinitely important and infinitely responsive to the play of the author's imagination.

That is certainly not meant to suggest that Literature is only "Fiction". Does anyone imagine that to write of characters in history and biography one is not using imagination that only differs in degree from when one is writing of characters in fiction?

Let us quickly get rid of two misapprehensions in case they linger in the mind of anyone intelligent enough to be reading this book. There is the fool who says, "I don't read novels because I like to read only the truth." Let it be abundantly clear that nothing could be more childishly wide of the mark. Truth is not so simple, so narrow, as that. It is in very fact Truth, the deep and difficult truths of life and of human character, which the great novelist by his genius and his insight and his integrity shows to us. Such fools must be left to the truth of "facts" as presented to them by propaganda and the popular Press. But let us be careful that we carry no taint of this outlook within ourselves.

The second fault is in the same category: only to be mentioned so that it may be *completely* avoided. There is the foolishness at the other end of the pole which does not despise fiction but thinks that there is nothing else but fiction. To such a simpleton, books are, quite simply—novels. There are indeed often only two sorts of novels: with or without Love. The whole thing is as simple as that.

Do not let us be altogether too scornful! For it is very easy to pay insufficient attention to non-fictional prose. Perhaps, we feel, it will be rather heavy, rather dry. . . .

Again forget all those distinctions! For what is all literature, by whatever name, waiting to do for you, but to spread out for your choice tales and descriptions of men and the deeds of men and the minds and thoughts of men—the world of men *in all times* and *in all places*? Even with modern inventions few can travel all over the world—fewer still can do so with the discerning eye of the born writer. No one yet has really invented a Wellsian Time Machine. Books are both the time machine and the space machine. The green swamps of Florida or the blinding heat of the Sahara, the doldrums or the staggering deck in a gale, the men of the mine or the men of the mountain; the Court of Montezuma, or of Queen Victoria; American Revolution or French Revolution; Arabian Nights or The Hundred Days: they are all waiting for you in books, whether they be called novels, histories, essays, biographies, autobiographies, whether characters be real but re-imagined or imagined from the start in the author's brain.

But how to *choose*? We are like the little boy seeing the party supper-table. No, the choice is more bewildering and dangerous than that: it is as if amongst the trifles and jellies there were swill and poison too, camouflaged swill and poison. We can suffer from more than indigestion. . . . That advice a few pages back about the Best Hundred Books may be good, but it is not much more than negative advice. It is not enough.

Let us concentrate on fiction for a while. If literature is a matter of achieving truth by a creative effort of the imagination, then surely the criterion of a good novel is: is this novel true to life? That is the great test: do these people live, would they behave like that, are we suddenly hit with a glowing conviction, "yes, that is exactly what I have felt but I have never been able to put it into words!", "that is just how the old girl down the road does go on!", and so forth? And there surely can be no real doubt but that we are quite capable of making that test for ourselves. However much we should give the author every initial chance as Virginia Woolf advises, we shall soon catch him out if he is writing cheap stuff. We shall easily catch him out so long as we retain our own integrity and are not so silly as to believe that fiction should rightly be a sentimental, mawkish travesty or exaggeration of real life.

If you want to acquire a taste for good fiction but are conscious that you have not yet done so, then do not treat yourself too harshly but have some patience. Start, we suggest, with modern novels, written by your contemporaries or near-contemporaries; they will appeal to you more easily. Your natural sense of what is good can be helped and guided by the reviews in papers and magazines, by radio book-talks, by the advice of friends (taken with discretion!). After a while you will get to know which are the better publishers.

Indulge your own taste within reason. If you hate an author that you are assured you ought to like, then you hate him and that is that. In ten, twenty years' time you may find you adore him. If you like an author, and are satisfied as to his integrity, then devour him if you want to, wallow in him and don't feel that all the time you should be "getting on" with somebody else!

And then the Classics in fiction. It does not greatly matter if you have not read them all (few of us have!); it would matter much more if you had stuffed yourself with them against your real desires and had never once re-read a book because you loved it. The benefit of reading comes slowly and gently and unawares.

Beware above all things of becoming a literary snob! Treat such people with the contempt they deserve; avoid them; let them despise you if it pleases them to do so. What does it matter that they have read the latest novel, if its reading has left them as silly as they were before; what benefit is it if they can always say who wrote what or what character comes out of which book, if they have never read half those books and have derived no benefit (through lack of real brains, real imagination, or real humility) from the other half? There is all the difference in the world between knowing who Becky Sharp "is" and having lived with her through the whole of *Vanity Fair.* Really to know that clever and scheming lady is a liberal education in itself. You may have met a Becky Sharp in real life; but you are not a Thackeray, to be able to have seen into her chequered soul and to have illumined a great chunk of humanity in the process.

Of course, nothing that has been said here should be taken as an effort to discourage anyone from reading the Classics. It is simply a warning against a forcing process. Lucky indeed is the individual who has his mind stored with the great characters of fiction; they are a joy to himself and—mark this!—a bond of union between him and his like, a common heritage and tradition. If you are not such an individual, then you are not lucky. You may slowly arrive at such a position, *but there is no cramming short-cut.*

One other thing: do not forget that a Classic rarely attains that status until many years—perhaps fifty or so—after the author's death, and so do not neglect the writer recently dead or even one who, still alive, has yet been writing for so long that his worth has already been partially discounted or forgotten. The beginning of our century was undoubtedly a time of great novel-writing: Wells, Conrad, Galsworthy, Bennett, Chesterton, Maugham and the rest. And incidentally a recent woman novelist likely to be forgotten, whose insight into human foibles, particularly men's, is delightful and devastating: E. M. Delafield. And one whose ear for the character-revealing little slice of conversation was that of an angel's: Sinclair Lewis.

But this is not the place to particularize or bandy favourite authors. Let us instead look at the art of the novelist a little more closely. In what lies that art? In the ability to unfold a story? Essentially, yes. But that is by no means all. The novelist must imagine his characters *vividly*—get under their skin, make them live and watch them live. Conrad has told to what great pains he would go to be able to make his characters live, so that he felt he knew what they would say, what they would do, what they would think, in *any* circumstances.

There are many other authors who have expressed the pains and hard labour of authorship, Anthony Trollope for instance, whose *Autobiography* is useful reading for any aspiring writer inclined to be too precious of himself in the sacred name of art and inspiration.

Effect, in other words, is not produced by luck or without effort. The novelist with a big theme is rather like a General marshalling and controlling his forces. The characters while remaining true to life must not run away with the story, out of the frame, out of the theme; then sometimes the wide canvas must be painted, sometimes the most intimate details of thought and word and personality; and the two must fit. Let us take one brilliant effect, and seek to analyse it, even though in pulling it to bits we shall hardly increase its beauty. It is from *Vanity Fair.*

Thackeray is going to paint a picture of one of the tremendous turning-points of history, the defeat of Napoleon at Waterloo. He does so: that amazing scene of Brussels before and during the battle: gaiety, gossip, fashion; the great Ball; then the soldiers called to the battle; then rumour of defeat, panic; and finally flight for the cowardly, and news of victory for those who have had the courage to stay. But this is not a history, it is the story of a set of characters. And so it is they who are used to bring this scene before our eyes, the preposterously cowardly Jos Sedley, the scheming Becky herself; and Amelia, the heroine, so sweet and good and so pathetically and innocently enraptured with her new, handsome, lovable but inherently weak husband George—George who avails himself of this hectic gaiety of Brussels to be secretly unfaithful to Amelia with Becky Sharp. These are the protagonists of the story, and the story must go on. Thackeray ends his chapter with a description of the end of the battle. Then this:

> "No more firing was heard at Brussels—the pursuit rolled miles away. Darkness came down on the field and the city; and Amelia was praying for George, who was lying on his face, dead, with a bullet through his heart."

That is so unexpected. That hits you between the eyes—and sets the story racing forward again, like a well-managed ship, on a new tack. . . .

And now a word about biography in all its forms. It is indeed true that it need not and cannot be separated fundamentally from fiction; but there are of course differences. The novelist can invent the thoughts and words of his characters, and if he is an artist gain much truth thereby. But he will usually do better to get his historical truth by making the protagonists of his story not the central characters of the times. For the real historical figures we feel, as readers, that we want more often a different approach. We want the artist-historian to come along, to read and read and digest for us, and then to present from his own skill and knowledge and imagination these great personages as real live figures, in the round. Then each biography lights up for us a patch of history in a way that is unique. Sir Arthur Conan Doyle, in a book called *The Open Door*, a guide to good reading, tells how history had seemed ineffably dull to him until he came across Macaulay's *Essays*:

> "What a noble gateway this book forms through which one may approach the study of letters or of history—Milton, Machiavelli, Hallam, Southey, Bunyan, Byron, Johnson, Pitt, Hampden, Clive, Hastings, Chatham—what nuclei for thought! . . .
>
> "When I was a senior schoolboy this book . . . opened up a new world to me. History had been a lesson and abhorrent. Suddenly the task and the drudgery became an incursion into an enchanted land, a land of colour and beauty, with a kind, wise guide to point the path."

That is one of the other approaches to history which we touched on at the beginning of our Chapter VI; it is really the *complementary* approach to that of the whole-story-of-Man method, and if both appeal to you so very much the better. There is one great writer who certainly has the wide view but who is yet always showing how he has learnt by what must have been a tremendously extensive reading of biography: Bernard Shaw. In his Prefaces particularly he is continually illustrating his points by reference to the lives of the great.

There is another and rather particular way in which biography can help us to be an understanding sort of person. The lives of the great in Art—Music, Painting, Literature itself—can often give us a better appreciation and love of that art. We may of course sometimes be given a shock—the perfect artist is by no means always the perfect liver—but that sort of shock must be risked.

And do not ignore *Auto*biography. You have there something, since thoughts at least can be legitimately re-created, more closely allied to fiction. Yet once again of course it differs: one cannot write about oneself with the same detachment as of a created figure. Indeed autobiography is one of the most difficult and delicate of arts; he who can successfully steer a right course between too much candour and too little, between egotism and mock modesty, between the *little* incident which is revealing and that which is boring, is a rare sort of person indeed. We can learn a good deal in literary manners from a good autobiography. Charles Lamb achieved perfection in miniature here in some of his essays. Of the moderns there is Sir Osbert Sitwell and one whose poems almost began this chapter, Siegfried Sassoon.

We have come near to the end of this chapter and have not once mentioned English Literature as such. Nothing about this *school* or that "influence"! No mention of *The Canterbury Tales*, or Shakespeare or Bunyan or Addison's *Essays* or the Lake Poets! But that is really not so much surprising as inevitable when we consider the method we are following.

Chaucer in his Prologue to those Canterbury Tales shows how he can beat a hundred novelists at a neat thumbnail sketch. Shakespeare's sonnets are in the nation's blood:

> Shall I compare thee to a summer's day?
> Thou art more lovely and more temperate:
> Rough winds do shake the darling buds of May,
> And summer's lease hath all too short a date.

But it may well be that we had at school too much for our liking of the Classics and the History of Literature. If that is so, then we shall do well to give them a rest—so long as we do not leave them indefinitely.

Finally there is one other truly tremendous omission in this chapter; the whole of Literature besides the literature of the English-speaking peoples. But again the omission has been intentional—one does not learn to run before one can walk.

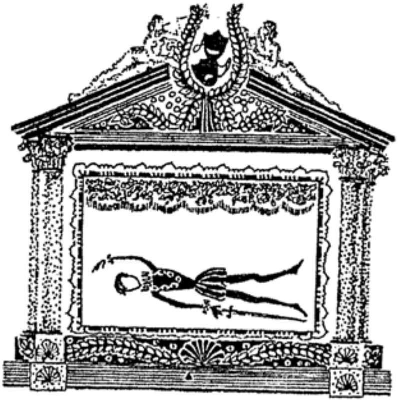
Some books in translation have of course become almost part of our own heritage—to take a few varied examples, the many translations of Homer's Iliad and Odyssey, Cervantes' *Don Quixote*, the French romancers, Alexandre Dumas and Victor Hugo (or on a rather higher plane, Balzac and Flaubert), the nineteenth-century Russian novelists (notably Tolstoy, Dostoevsky and Turgenev). Then at the other end of the scale, poetry in any other language is often hardly worth reading, save by a specialist student, except in the original. (FitzGerald's *Rubaiyat of Omar Khayyam* is hardly an exception since it is said to be virtually a new creation.) But on the whole it will only be the classics of another tongue that merit and receive translation, and what we have said of the English classics applies perhaps all the more to the rest of the world's : walk we must first, but see to it one day that we run. . . .

The real danger for most of us in these days is the danger typified in the busy and specializing student who vows that he never has the time for anything but his text-books. He is indeed laying up trouble for himself. He is like the child—if such exists—who refuses an ice cream or a jelly or a chicken sandwich because someone has told him that he will only get really strong and fine and curly-haired if he eats vitamin pills or nice black crusts. He is being an unconscious masochist—which word, if you do not know it, please look up in the dictionary! . . .

BOOKS: First Q's *The Art of Writing* needs to come at the end of this chapter as much as at the end of the previous one; and his *The Art of Reading* must also be mentioned.

Palgrave's *Golden Treasury* is what one might call the standard anthology of lyric poetry, but it does not bring you to very modern times. Another famous compilation is Q's *The Oxford Book of English Verse*. Penguin Books publish several anthologies of English verse, by periods.

For the rest, if you really feel you want a guide to "Best Reading" there is a helpful list in *Words at War, Words at Peace*, by Eric Partridge (Muller). A useful reference book and guide to the English classics is *An English Library*, by F. Seymour Smith (Cambridge University Press). Arnold Bennett's *Literary Taste* sets a high standard, and will be welcome to the really earnest seeker after a knowledge of the world's classics.



CHAPTER XII

MAN PRETENDS

(The Play; the Film)

WE will suppose that you have the urge to write a play. You have an idea, a *theme*. And it won't let you alone.

Your central idea—for the sake of argument—is, The Hypocrite. You have observed in real life how often the hypocrite—the man (or woman), that is to say, who pretends to be so much better than he is—can so often "get away with it". He imposes his false valuation of himself on others. Particularly he hoodwinks the genuinely good person, the person who is really kindly disposed and is guileless and simple. How irritating that is! How tragic! And yet sometimes how comic! If only you could get that idea across in a play. . . .

Very well, then, you will try to set about it. But how?—just having the idea will not get you very far. You need a plot. And characters.

First of all you have obviously for characters the hypocrite and his dupe. And plot? The one ruins the other. But how?

The thing to do here is to think about your characters—furiously. It is the same as with writing a novel, only perhaps more so; you must know your characters so well that it *comes* to you what they would do.

The dupe—call him Mr. D—is rich, and so the greater his ruin. Good! The hypocrite—call him Mr. H—sponges on Mr. D. Obviously! He comes to live with Mr. D—and has no intention of leaving. Mr. D is a family man?—good again! The family hate Mr. H, naturally; *they* see through him. They tell their father; but he will not take the slightest notice, he thinks in fact all the more of the good Mr. H, and that his family are merely being jealous. Better and better!—we are getting more characters and they are behaving "*in* character".

But plot? Action? Conflict? One has read somewhere that a drama must in fact be *dramatic*, that there must be conflict. Conflict, then, between Mr. H on the one side and Mr. D's family on the other, with Mr. H being scheming and vile and oh! so hypocritical. Mr. H—yes!—Mr. H makes love to Mr. D's daughter. And Mr. D, the foolish man? Why of course, he thinks it a good idea; he even forbids the girl to marry the man she really loves and tries to force her to marry Mr. H. Conflict again. And suspense (one must have suspense): how will the girl get out of *that* difficulty?

Enough of that. And let us not keep up the pretence any longer: you would, if you had been writing that play, have been writing Molière's *Tartuffe*, or rather you would have been if you possessed Molière's genius. Indeed, let us take it just a little further, to show how a practised dramatist does get what he wants. How would you start your play? You need to show how the hypocrite has slowly, insidiously wormed his way into his foolish host's confidence. Yet it is not as with a novel; one cannot slowly build up a situation—one has only two or three hours of action at one's disposal altogether. One needs, too, to explain and introduce the characters to the audience. What does Molière do? He plunges straight into intense action: an unholy family row because the grandmother has already had enough of the hypocrite and is leaving the house—very volubly—because she can bear it no longer.

Now why have we started this chapter in this way? Certainly not to teach you how to write a play. It is, rather, to make clear certain things about plays in general; in fact, to be explicit, four things. They are these: first, how essentially artificial a thing a play is; second, how greatly a play differs from a novel, and yet is still in some respects parallel; third, how a play—if it has any pretensions to anything more than a "pot-boiler"—will have a theme; and fourth, how it will make you see things about life that you have never really or properly seen before.

Two and a half hours or so, in which to get across the story of a lifetime or even several lifetimes, and all that in a three-sided room with the characters coming in and out with apparent naturalness, making themselves and their motives and their past histories plain merely by what they say: *there* is certainly artificiality for you. Yet it is the nature of real art to extract benefit from its very restrictions. That is what the good stage play does. Characters *seem* natural. But they are really, rather, the very essences of themselves. Their talk is the refined gem, the diamond from the amorphous lump of coal which is the conversation of real life. Read a play of Bernard Shaw's—*Heartbreak House* perhaps as an extreme example—and then ask yourself soberly whether people really behave and talk like that in our dull real world. But who wants to be sober in listening to a play? You want to be struck of a heap.

Some novels give something the same effect, a sort of sublime and revealing exaggeration of character. Dickens does it. But it is to a lesser degree; because the novel can explain, and describe, and analyse and take its time. It can take pages in showing what someone *thinks*. Not so the play. And so the play appeals more directly and more exclusively to the emotions, as opposed to the intellect—we spoke, did we not, of being struck all of a heap? It is not necessarily the lesser art for that; it is different. Nevertheless, there is still that underlying similarity: the playwright, like the author, is illustrating to you the truths of life by showing you a slice of life. He is showing you *people*.

The good play has a theme: a theme to be illustrated by people in action. It may very well be a simple theme, something that can be stated most baldly: hypocrites take advantage of the good but gullible; procrastination is the thief of time; love is all. They are platitudes almost—*until they are lit up for you* by the dramatist's art.

Molière lights up *Tartuffe* for you, until that arch hypocrite is the embodiment of all that is sly and vile and clever and devilish and dangerous—just as Becky Sharp in Thackeray's novel is lit up for us as the embodiment of scheming and unscrupulous womanhood. Yet what would be the good of saying baldly, Beware of the Hypocrite, or Beware of the Charmer?

This, in fact, is the criterion of the great play as it is of all great art: that it makes you *see*, that it lights up the bald and platitudinous statement, the ordinary and the everyday and what you thought was the obvious—lights it up so that you appreciate it with a sudden flash of understanding. There is a book, from which we shall be quoting again in a moment, by the dramatist C. K. Munro, which puts this point even more definitely. We ordinary human beings, he says, don't "see"—not, that is, as the artist sees, with understanding and discrimination. We merely "look". That is what we have to do as a mere biological necessity in order to survive: look about and mind out. We need the artist to "see" for us—and it is very convenient for us, incidentally, when all we have to do in this instance is to pay for a comfortable tip-up seat in the theatre or cinema and let him do it for us.

But that is, of course, so long as we are sufficiently receptive to do that seeing when it is pointed out to us. And that brings us right to the very kernel of this chapter. Why do we feel the need to know something about plays, and which are considered good plays and why they are so considered? To become, we might answer, reasonably well-educated people. But what beyond that? The answer is surely that the more well-educated and knowledgeable and understanding people there are about, the more good plays will be seen in the theatre and the cinema (which is not the same thing as saying the more curious, queer, precious and highbrow plays). In other words—and again as we suggest, implicitly or explicitly, in the other chapters on art—the role of the appreciator is not a passive one.

What, then, is a good play? Do not let us be too highbrow about this. No one wants to confine himself to a course of the classics and the latest experimental symbolism, unless he is a pretentious prig. Any play, on stage or screen, is good if somewhere in it it has made you feel deeply. The harm is when you accept the bad play, the play that is hopelessly untrue to life, that shows life as your better self knows that it is not, whether the angle be mawkish or brutal or just silly. Let us be clear here. The bad play is that which shows life wrongly while pretending to show it rightly. Nobody pretends that a Musical Comedy shows life as it is; but then the author is not pretending it either. You go to be amused, to "escape" from reality. Occasionally, why not?

We must take this business of appreciation a little further. There is a lot of highbrow nonsense talked about plays, and we must beware of it! A play doesn't necessarily have a "message", or solve a problem, or have something to "say". To quote for the second time from C. K. Munro: "The thing a play is really about can of its essence never be said. If it could there would be no need to make a play about it."

> "One of the best ways," he goes on, "to discover what a play is about is to wait till it is over and then consider the total impression which it has made on you. If you can find a name for that impression, then that is what the play is about. But very likely you will not be able to, and then the only way to describe it is to name the play. If, however, on trying this experiment, you can find no particular impression at all, don't be discouraged, for many plays are not about anything in this sense. That is why Shakespeare is greater than the popular writer whom we may call Mr. P. Q. Man is an illogical animal, so he doesn't object to going about with the idea that Shakespeare is the greatest dramatist, while he knows perfectly well that neither he nor his friends could sit with enjoyment through a play of Shakespeare's, whereas they derive immense enjoyment from the plays of Mr. P. Q. Were he logical, he would be constrained to assert that Mr. P. Q. is greater than Shakespeare, indeed that Shakespeare is nowhere in comparison with him; and this might be true, were it not that, apart altogether from what

> happens actually in the theatre, you can carry away from some of Shakespeare's plays something it is very difficult to find anywhere else. And *that* is what the play is about. The essence of *Hamlet* is not that a man couldn't make up his mind to kill his stepfather, but that simple impression which you feel you have received when you come home, which you cannot describe except by saying that it is that aspect of reality expressed by the play *Hamlet*."

As that is almost the first mention of Shakespeare in this book it warrants a slight digression.

There is one phrase in the above with which we would quarrel, that is to the effect that the ordinary person cannot sit through a play by Shakespeare with enjoyment. We will call it an exaggeration on Mr. Munro's part in order to make his point. Some people are lucky enough never to have been put off Shakespeare by too much of him at school. They lap up the fairy scenes and the Bottom scenes from *A Midsummer Night's Dream* when they are about eight years of age, and go straight on from there. Others are not so lucky. But let them go to a well-acted production of one of his plays—preceded by a film version if they like—and, in spite of what Mr. Munro says, they will almost certainly enjoy it. After all, a play is made to be seen, and seen well done. If the experiment fails, then it is the old story again, you must wait until the reaction of childhood against being made to learn has worn off further, and then you must try again. It will repay you. For Shakespeare is in the *tradition* of the English-speaking peoples. He is in their blood. As somebody naively said, "he is so full of quotations!".

Now let us consider the Film, not as a mere particular kind of play but as something contrasted.

The film is at once more and less artificial than the play. To appreciate the artificiality one has only to consider the actual making of a film, which all of us have read about if we have not seen: the "set", where scene suddenly gives place to snaking cables, harsh lights and shouting men; the snippet of a scene done again and again. Or consider the amazing "shots" which a camera can make, where camera becomes artist and competes in its effects with the other visual arts, the painter and the designer and the draughtsman.

But on the other hand the film is much more real. The scene can be, and is, anywhere in the real world, not a concocted three-sided box. This has its obvious advantages, but its disadvantages too. It means that an artificiality of scene-making which would be accepted without question on the stage, usually jars at once. It means also that the stage convention of someone standing before a backcloth and speaking "fine lines" will not with anything like the same ease be accepted.

Indeed it is a useful and reasonably fair generalization to say this: that, just as the play cannot appeal to the reason and intellect as a novel, so even more must the film appeal primarily to the emotions. It is not necessarily a lesser art for that, but, again, a different art. Think how wonderfully effective the camera, with its mobility, can be. Read *For Whom the Bell Tolls* by Ernest Hemingway, and you will be left with a profound impression of the tragedy of the Spanish Civil War; see the film, and you will be left with a profound impression of a tragedy much more personal and emotional—the heart-rending sensitiveness of Ingrid Bergman's face as she portrays the woman who must leave her lover to his death. Think, too, of the sudden shifts the camera can make, from pursued to pursuer for instance, from what is happening to what will happen in a moment—a trick of the camera called "montage" by the experts and used more often than one realizes. As Dilys Powell says, the films can make it all so personal: it is *you* who are going to be bumped off, if you are not careful, by that gunman you have just seen lurking round the corner; it is you who in *A Matter of Life and Death* go trundling off to the operating theatre, with only that restricted, flat-on-the-back view of the slowly passing corridor ceiling to bring it home to you where you are going. . . .

A tremendously powerful emotional appeal, that is what film plays have, or can have. They are then, for that reason—and because, being capable of infinite mechanical multiplication they are cheap and ubiquitous—a very important influence in the lives of men and women (and children). That "un-passive" role of the appreciator therefore is all the more important. We get, they say, the films we deserve, and no doubt that is largely true. Woe, then, to the intelligentzia if it spends its time gabbling fascinatedly about technique and neglects the wider issue that many films—many too many films—are, not to put too fine a point on it, just plain bad—execrable offenders against good taste, decency, and any sense of fitness, and that rule of Quiller-Couch's which he called *propriety*.

It is indeed necessary to end this chapter with a serious effort to answer the question—the admittedly naive question which nevertheless many not too priggish people must have asked themselves at one time or another—"how ought I to look upon plays and films, what ought I to know and think, if I am going to be cultured and intelligent on the subject?" To try to answer that question will serve, too, to bring this chapter back into the framework of this book—which perhaps so far it has remained rather conspicuously without.

We must come back for a moment to history, and pre-history. Anthropology—there is no getting away from that subject—and even physiology come into the argument.

Early Man danced and sang. He had remarkably good vocal cords, and limbs remarkably supple and expressive. He liked to use both, and he did use both. He found joy in exercising, one might say, that double-entity of his, the body-mind. He danced, therefore, in his cave or round his fire. He mimed. He *pretended*. Sometimes perhaps it had a practical purpose in his queer embryo-religious system of sympathetic magic: "enact the killing of the bison, and tomorrow we shall really kill the bison!" But the urge, surely, was in reality deeper than that. It was an urge to express himself, to find an outlet for his powers and, above all, for his emotions. Once more we repeat the idea: Man is above the animals not merely because of more brain but because of more imagination.

Complete that idea with the one suggested at the beginning of the chapter on Language, that Man inevitably told himself stories—and fanciful stories at that. It is all an exercising of the imagination, it is all the beginning of art. So—in some such way—was born, and grew, the art of the drama.

To say baldly that drama began with dancing is over-simplification and perhaps misleading. But visualize this primitive story-telling in action, this chant-dance-mime, this tremendous and significant release of emotion, and the idea becomes intelligible. To say that drama has its origins in religion is true too: the religion of magic, the solemn and dreadful drama of sacrifice, the story of the God enacted before the crowd. Nor is that really surprising or fantastic; for the religious emotions are the deepest emotions, and this is the superlatively best way of giving release and meaning to them. Even when drama has found its full intellectual strength with the Greeks, the season at which the tragedies of Aeschylus and Sophocles and Euripides were enacted was at the festival of Dyonysus and the subject by tradition the lives of the children of the Gods.

So to the answering of our question. Perhaps it is only labouring the obvious. But let us state it. To be able to chatter glibly of technique, to know what is "*on*", to know who wrote what and what is written by whom, though no doubt pleasant and even enviable, is of no virtue. What matters is that each of us should be capable of a great emotional response to a medium designed to evocate emotion, that we should be able to "see" when the artist makes us see, that we be not so dull-minded that we cannot discern and take away that "something" from a great play of which Mr. C. K. Munro speaks.

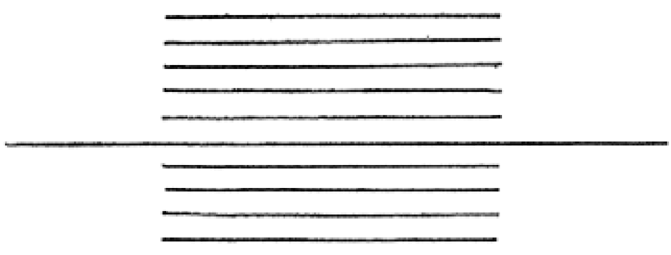
It is not easy, and no doubt we should not *always* be striving too hard to achieve it! But this at least is worth realizing: that when Man began to pretend, then he set himself on the road, however strange it may seem, to achievement in an art both great in itself and great in its influence upon his outlook and his understanding.

BOOKS: C. K. Munro's book is *Watching a Play* (Gerald Howe, 1933). For the rest, it would be a pity if one were to run away with the idea that plays cannot sometimes be *read* with profit or entertainment. A whole generation, one might almost say, has brought itself up on Shaw's plays—perhaps not knowing which it liked best, the play itself or the "argument" that lay in the brilliant preface. The preface to *Back to Methusalah* might have been cited as necessary reading at the end of the Biology chapter. But as an antidote for thinking—as some people do—that Shaw has only written "plays of ideas", or, worse still, is only a funny man standing on his head, one should read—or see, or hear—*Saint Joan.*

CHAPTER XIII

MAN HAS EARS

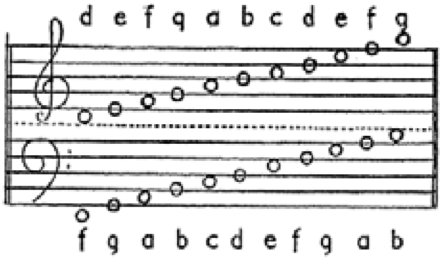
(Music)



THAT is the basis of music, or rather of the writing of music. It could hardly be much simpler. And that long line in the middle represents *Middle C* on the piano. Most people know where that is—and if they do not it will hardly be difficult for them to find somebody who can tell them. When they press down that note they are, if they are interested to know, making a wire vibrate at a frequency of 256 v.p.s. (vibrations per second).

The language of music is the only universal and completely phonetic language. It means exactly what it says and anyone can easily learn to read it (or at any rate read it slowly!).

To take the matter a little further, the eight notes of the octave are given the first eight letters of the alphabet, and in normal writing of music the middle C line is left out, and the "stave" (which is the thing at the head of this chapter) is split into treble and bass "clefs" respectively, and you then have this:



In other words, round things (open or blocked in, with and without tails) rest either *on* or *between* the lines and each represents a note (or a sound of a certain frequency of vibration). Those on the lines are called "lines" and those between "spaces"; ignoring the notes outside the five lines of treble and bass we get the string of notes which anyone who has ever begun to learn music as a child will remember, only too well, and with perhaps some grief and pain: F-A-C-E, and E-G-B-D-F for the treble; and A-C-E-G and G-B-D-F-A for the bass. They are, you will notice, shifted one place to the right for the bass compared with the treble—what a pity they are not the same! The notes shown here are the longest in duration of time that are normally used, called rather absurdly *semibreve*, or literally "half a short" (there being however longer ones in existence). All the other notes—first with a tail and then blacked in with more and more tails—are each half as long as the one preceding it. And the answer to the question, "how long in duration is, then, the biggest?", is, conveniently: "within reason, just so long as your interpretation of the music dictates".

One more thing, and you have basically all you need to have printed on a piece of paper for it to be translatable into sound and the same sound all over the world (always presuming you are using the same instrument and your instrument is in tune). This you need because a music has *rhythm* or *accent* or *beat*. You divide your music therefore into "bars" by vertical lines, and each bar has so many beats and no more—one semibreve, say (which is the same as four crotchets) or three crotchets, and so on.

But we are not teaching music in this book, any more than we are teaching any other subject. It is, rather, once again that idea of trying to reduce an anxious inferiority complex about it or an irritated reaction against it because we want to appreciate it happily and easily but are wary or suspicious of the patronizing highbrow.

It should be quite possible to appreciate music happily and easily—always provided we realize that it cannot be done without first taking some trouble. One gets the impression sometimes that the only people who are happy about music are the true experts and enthusiasts and the people who don't care a damn about music and never intend to care a damn. The rest of us are *worried*—worried because we feel we ought to appreciate good music but in practice very often don't. It would be a pity if we lapsed into the "don't care" class.

Charles Darwin said: "If I had my life again I would have made a rule to read some poetry and listen to some music at least once a week, for perhaps the parts of my brain now atrophied would have thus been kept alive through use. The loss of these tastes is a loss of happiness and may possibly be injurious to the intellect, and more probably to the moral character, by enfeebling the emotional part of our nature."

Darwin was a serious-minded, very practical and hard-working scientist. And yet he said that. He too must have been one of the worried ones. But he postponed doing anything about it, apparently, until too late. We do not want to feel like that in our old age.

The truth is of course that none of us can or does do entirely without music in our lives. It is too much in our blood, too much in the human make-up. That need not be stressed in this book: we have said enough in other chapters about Man being an animal of emotion as well as of reason and of the idea that he learnt to speak merely by wanting to sing, indeed by not being able *not* to sing. Rhythm and music are simply a part of our environment that we have learnt to respond to, with intensity: why, nobody knows, it is part of the nature of things.

But it is a far cry, you will say, from the primitive savage who yodels from pure *joie-de-vivre* or responds bloodthirstily to the war-drum, to Bach and Beethoven. Of course it is. But there is a certain continuous path between.

Is it of any use to say to the anxious enthusiast, "Don't be afraid of your own taste; like what you like—and leave it at that"? The first part of the advice is probably useful, particularly to the diffident. But the last is of course going altogether too far. Or, rather, not going anywhere near far enough. Taste needs to be educated, and needs something to educate itself upon. For most of the rest of this chapter we shall sketch and consider something of that education.

First a word of warning—and a word that applies for that matter to all the Arts. Surely the obviously correct approach to any piece of music accepted as "a Classic" should be: thousands before me have considered this good, it has stood the test of time; let me then consider it carefully and openmindedly and see whether in the end I too like it! One may never grow to like it; we humans differ immensely and we shall never all like all that is good. But to admit that is a very different matter from indulging in the opposite reaction—which seems so prevalent at the present time. This is the violent reaction against "high-browism" of any sort, it is the reaction which says, "Thousands of stuffy people in the past have liked this and they tell me I ought to like it; very well then, I won't!" The fault is initially and quite largely of course with the people who do have that annoying habit of telling us what we ought to like. . . .

Let us now consider some of the hard plain facts about music. There are certain elementary ideas which all too many books upon music assume are known, which indeed many people themselves too easily assume they know. Just *why* do we have a scale of eight notes, just why does a piano have sharps and flats, just what do we mean when we talk about major and minor keys and harmonics and *timbre* and tone colours and all the rest?

Doh, Ray, Me, Fah, So, La, Te, Doh. Those are the curious noises by which we are taught to distinguish the eight notes of the octave. Forget that they are called that—the science of music doesn't deal in such childish simplicities—but do remember that we begin and end with *Doh.* We come to *the same note higher up.* Everybody recognizes that, they can't help recognizing that. *Why?* For the simple reason that it is vibrating twice as fast; middle C on the piano, as we have said, moves at 256 v.p.s.; the next higher C, 512 v.p.s., the C below 128 v.p.s. and so on. Put another way; halve the length of a vibrating string, and you get a note an octave higher. Aristotle found that out. He also found that if you took three-quarters of the string you got a note five up from the start, A B C D *E*; and that if you took two-thirds of the string you got a note *four* up. We say that the notes that are four and five up are at *intervals* of a fourth and a fifth from the key or home note. And these three notes, at intervals of an octave, a fifth and a fourth, are always important and fundamental notes, they occur very often in simple tunes, we *recognize* them and respond to them easily. Which is surely what you would expect.

But beyond that it is all, rather surprisingly, largely a matter of convention. Get anyone to play on the piano any "major" scale of eight notes and it sounds just right to us. But it is only because we have been brought up on it. A Hindu or a Bantu would not so respond. A Greek would hardly have done so. Indeed we do not necessarily and invariably do so ourselves, for a "minor" scale is different, and that too—though perhaps not so obviously—satisfies our ear.

The only basic thing we can fasten on to is the mathematical one that the "pitch" of each different sound is the result of something vibrating at a certain rate. Purely arbitrarily, we in the Western tradition divide the distance between one note and the note of twice its vibrations into so many "tones" and "semitones". Beyond the division of a semitone we do not expect our ear to differentiate—but the Indian musician does. We can then give a definition of a major and minor scale. The intervals between the notes of a major scale are :

Tone—Tone—Semitone—Tone—Tone—Tone—Semitone.

A minor scale runs :

Tone — Semitone — Tone — Tone — Semitone — Tone —and-a-half-Semitone.

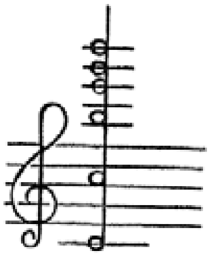
If then you play "in a minor key" you use a slightly different series of notes, with obviously different results.

And what about the "black notes" on a piano? They are there purely for convenience (though perhaps the sweating learner hardly thinks so). *Every* note on a piano, white and black, is a semitone away from the last note ; if then they were all the width of white notes even the biggest hand could hardly stretch an octave, and the piano would be about as long as a small room. In the key of C (that is to say where C is the "Doh" or home note) the two places in the scale where the semitones come are where two white notes are together ; and you therefore get a scale with no black notes in it at all. If you play something in that key you don't get any black notes either, unless of course you are told especially to do so by the signs ♭ or ♯, a flat or sharp, a semitone down or up—something, that is to say, "accidental" or superimposed. But remember that all this just "happens" so ; there is nothing particular or marvellous about the key of C.

That is all we can afford to say about scales and keys and intervals. Now for a definitely queer and interesting thing. It is this, that when you strike a note on almost any instrument *you set other notes going as well.*

You know probably the ordinary fact of *resonance* : that if you set a tuning fork vibrating, that fork will make another of the same note vibrate, or that, if you sing a note, you may make something in the room "ring" (and even break, so they say, if your voice is stentorian) if that too is its natural note. But this is something more. When you strike a note on the piano, other notes above it are also sounded, but in rapidly diminishing intensity. Further, the other notes sounded go up always in a certain progression, starting always with the note an octave above. This progression is called the *harmonic* progression—and if we follow the whole affair very far we become somewhat deeply involved in Mathematics.

The next point is of deep significance. Every musical instrument gives a varying degree of these harmonics, or, as they are also called, *partials* or *overtones.* That is in fact largely what gives musical instruments their distinctive characteristic, or what is called their *timbre* or "tone colour". A tuning fork gives no overtones at all. A violin on the other hand gives these when you play the note which we call Middle C on the piano:



A piccolo won't give so many of the higher harmonics—which is mainly why a piccolo sounds different from a violin, and also why, for that matter, a bad or a manipulated wireless receiver may make a violin sound rather like a piccolo. And one further point about harmonics: why high notes sound comparatively thin is that their overtones have climbed so high that our ear will not register them.

We are now going to talk about Harmony, which fairly obviously is something different from harmonics. Nevertheless there is a definite connection. The harmonics or overtones which a musical instrument—vibrating strings or reed or columns of air—produces are themselves in harmony; they are "harmonious", they are concordant not discordant, they do not offend the ear. (Try on a piano those violin notes shown above.) And again that is what you would expect; it is what we may legitimately call the biological angle coming in again, the idea that we humans as a part of this world's life will have evolved to respond to and appreciate the natural features of our world. *Naturally* we find harmonics harmonious: in fact we—or rather the musician—bases his harmonies on them.

Now add two other words that are always being used in music, and so take these three: *harmony, descant, counterpoint*. What do they mean? Very widely—and not in detail because amongst other things their meaning varies with their context—they all come to the same thing, which is, the combining of separate notes to form a whole that is pleasant and interesting and satisfying to the human ear.

For some fundamentally quite inexplicable reason, series of notes can give us something which we recognize as a melody or tune and which pleases us. Now the musician goes further—it is amazing to find that he hardly started going further, at any rate in this country, until the sixteenth century—and says, I will add to your pleasure by combining notes and melodies. I will set note against note (Latin *contra-punctus*, counter-point). Or I will ask you to combine your four natural voices—treble, alto, tenor, bass—each singing a separate melody and yet with a total result that will please you more than my mere single line of melody. That is what is usually known as descant.

And that brings us up, at once and quickly, against the whole subject of the *appreciation* of music.

The musician will look most severely down his nose at you if you say to him cheerfully and innocently, "Oh yes, I like a good tune!" And he will have some reason. He does not mind your liking a good tune, quite the reverse. But he will be saddened by the implication that you have never got any further than liking a good tune. You have not begun to appreciate harmony or counterpoint, the combining of notes or the combining of tunes—you are merely a "top line" appreciator (the top line of notes, or treble, being usually where the most obvious melody runs).

It is a very good practical training in the first steps towards better appreciation to take, say, a good hymn tune or madrigal and to see for ourselves that there is a good deal more to it than a top-line melody plus a lot of padding—that it is, rather, a tapestry of melodies. The Madrigal, *The Silver Swan* by Orlando Gibbons (published by Novello), is a good one to take; play, or get someone to play for you on the piano, the different parts separately and then together. Another example, more difficult, is No. 102 in the *English Hymnal*.*

For the rest, the best and only short advice to be given about musical appreciation amounts to just about the equivalent of a hearty and encouraging pat on the back. We are lucky in this age in that we have the radio and the gramophone; and so long as we are sensitive enough not to use them as a mere noise-we-miss-if-it-isn't-there and to insist on decent reproduction always, we need not be apologetic about our taste. We can cheer ourselves, if we like, with the fact that such an acceptedly civilized person as Sir Osbert Sitwell enthuses not, as perhaps one might pessimistically and bitterly expect, over the most "highbrow" music, but over ballet music, the gaiety of Rimsky-Korsakov.

Do not let us in fact talk about "educating our taste", but rather of widening it for our pleasure and the relief and release of our souls. Here, put baldly, are some practical hints to that end that musicians and well-wishers have laid down for our benefit:

(1) Don't try always to be reading something into music; don't imagine that it ought to be conjuring up pictures in your mind and that if it doesn't conjure up the right one you are guilty. The "descriptive"

* The alternative version of "O sacred head, sore wounded," harmonized by John Sebastian Bach.

piece, complete with sleigh bells and what-not, is rather obviously not music on a very high plane. On the other hand there is some music which by much less crude methods does definitely make us "see" something—dawn and then storm for instance in the "William Tell" Overture. But for the rest—why on earth should it conjure up something particular? Relax—and let it conjure up what it will.

(2) If you find you particularly like the music of one composer, then there is your chance—try to hear more, see if you still like him, and, if so, find out what it is you really appreciate in him. Play his music, by any method that is open to you, over and over again. Take an interest in him and read his Life.

(3) And then remember not to get completely stuck; avoid becoming the liker of merely one type of music only. Experiment at least just a little!

(4) *See* an orchestra playing. (That is to say, don't be just content with the radio or gramophone.) That may seem inartistic advice. But the mastery and verve of the conductor, the enthusiasm of the audience, the very sweep of all the violin bows together, will heighten the effect for you so that you will be carried away as you could not possibly be by sitting coldly in front of your wireless set.

There is another aspect to that luck of ours compared with previous centuries. If you read the history of music you come across a surprising thing. It is not only that harmony and counterpoint are so comparatively modern but that our instruments and our symphony orchestra itself are even more modern. A spinet has no doubt an old-world charm; but Mozart would surely have given his eyes for a modern grand piano. Beethoven's wind instruments could not do half the things that our flutes and oboes and French horns can do now.

The history of musicians, besides the history of music, is fascinating. Perhaps more than most, great musicians have led rather tragic lives: there are those who say that the two things go together and that Mendelssohn, for instance, would have written more great music if his life had been less easy and successful. Mozart died at thirty-five, Schubert in poverty at thirty-one; Bach grew blind and Beethoven deaf. . . .

"Make your own music!"—that is what most of us in our secret hearts wish to do, and what so few of us manage to do. It is the reverse side of our "luck" in having such easy reproduction of the experts at our disposal—nobody even brings his harp to the party now!

Yet those days of harps and parties could of course come back if we wished them to; and all of us could no doubt learn to play an instrument if we persevered. But not by reading books. Rather by joining with others and by getting someone to teach us. There is one book which can help there, a book written by Desmond McMahon, and published by Nelson, called *Music and Youth*, full of information about Clubs and Groups and Movements and Festivals and teachers.

Other ages have been so much more actively musical. Do not, incidentally, be misled by a word into the idea that the Greeks were particularly so. No doubt they were, largely. But rather they revered the arts as a whole. *Music* to them meant all that was governed by the Muses, and this included the dramatist and the sculptor and the actor and dancer as well as the musician. Elizabethan England on the other hand was really a musical, a cheerfully musical, land. You really were not educated then if you could not *read* music.

And is reading music and to sing a song "at sight" so very hard? To reach at least some little proficiency is not. But it needs a teacher—a personal teacher if possible and not one out of a book. He will take you gradually, first probably to that natural harmonic, "the interval of a fifth". Anyone can soon learn to sing that. And then the next note only, the interval of a second. And so on until an octave is covered. It can be done!

Finally, a few definitions of types of music and so forth, lest here too you should suffer unnecessarily a disadvantage when in the presence of the not-too-helpful and all-too-esoteric expert. Here they are:

Cantata: Originally anything sung. Now usually a short Oratorio, not necessarily sacred.

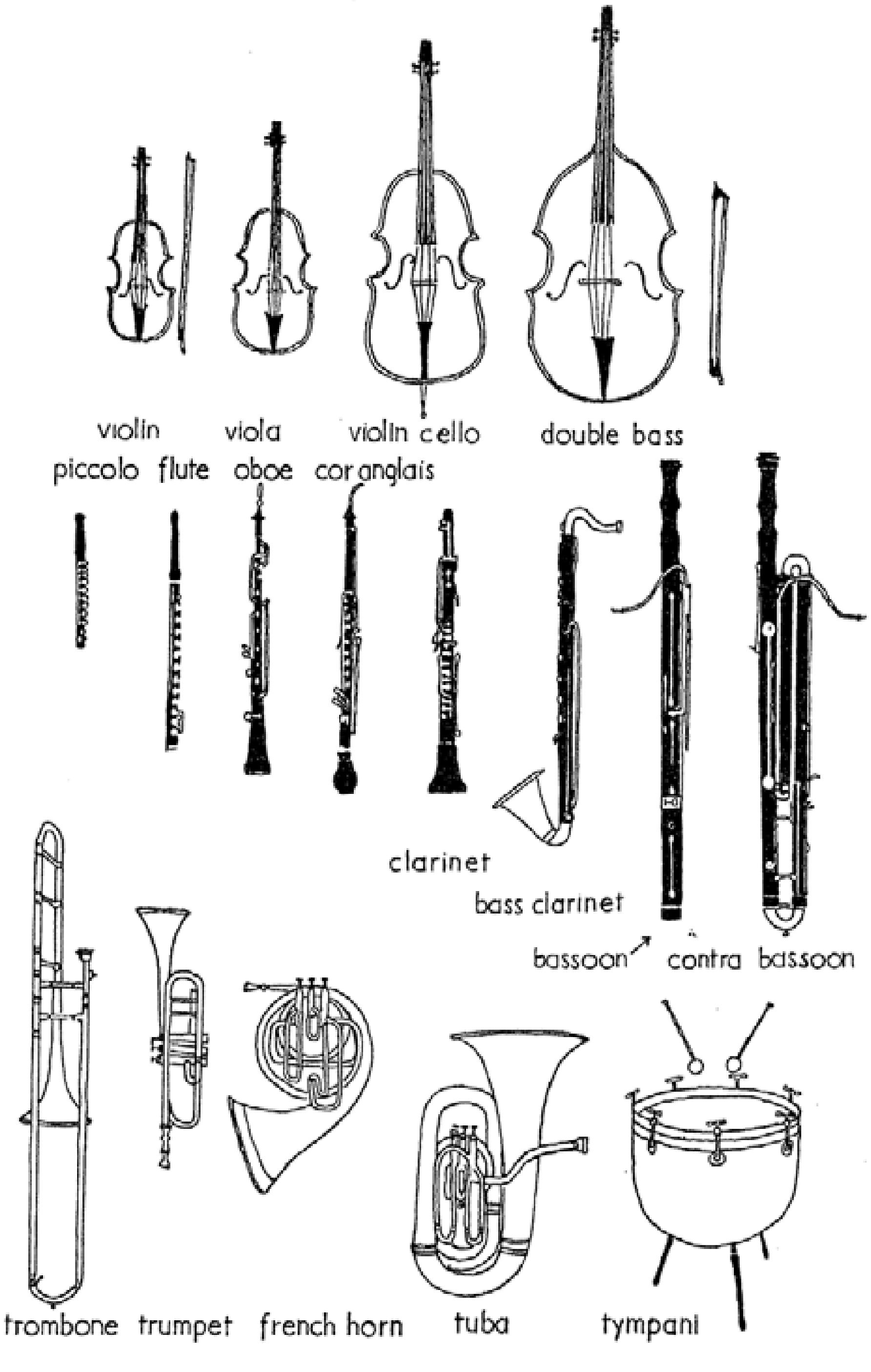
Oratorio: A sacred dramatic work for soloists, chorus and orchestra (e.g. Handel's "Messiah").

Sonata: Originally something "sounded" or played, as opposed to a Cantata. Can still be used as a generic term for any form of instrumental music—a symphony is strictly a form of sonata. But so is a Trio or Quartet (for three or four instruments). Therefore Sonata is now used to denote, more specifically, a serious and major piece of music for one or two instruments. A Sonata is generally in three or four "movements" or parts—one of which, incidentally, is a "scherzo" movement, which means light and gay, from the German for a jest, though somehow the word does not sound in the least like that.

Symphony: simply a composition for orchestra consisting of several movements—usually three. The modern symphony orchestra consists of about eighty members, including probably about thirty-six violins and violas. Berlioz's idea of an ideal orchestra, however, was one with 240 stringed instruments, not to mention thirty grand pianos; he never got it but managed once a total of 600!

Concerto: a symphonic work for one or more solo instruments with orchestra.

THE INSTRUMENTS OF THE ORCHESTRA.



Cadenza: a piece of exciting extemporizing by the soloist in the middle of a Concerto; now, more tamely, written down for him.

Overture: Originally a beginning or introduction by an orchestra, but no longer necessarily so.

Prelude: the same thing by a single instrument.

Fugue: "a cumulative composition built on a short theme". Or, one might say, counterpoint in action. The choruses of Handel's "Messiah" can be called vocal fugues.

Rondo: a piece of music where you come round again to the refrain. A rondeau or roundelay is the same idea in poetry or song.

Coda: a rounding off of music, a final repetition of the theme, a "dying fall"—sometimes perhaps, like King Charles II, an unconscionable time a-dying, one may think.

Modulation: changing key during the course of a piece.

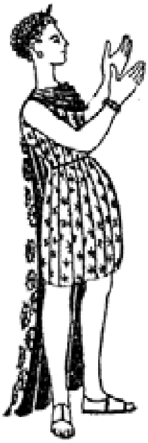
Motive: "the shortest satisfactory musical statement"—shorter than a "phrase", shorter than a sentence. Best-known motive: the four notes or "V" theme at the opening of Beethoven's 5th Symphony: da-da-da-*dah*!

BOOKS: Of books on music there are legion. Many books one has but to open to recognize as highly technical. But even the simpler ones, as has been said, seem to assume a fairly wide knowledge. Two exceptions are *Teach Yourself Music,* by King Palmer (English University Press), and *Get to Know Music,* by J. R. Tobin (Evans Bros. Ltd.). The latter is in the form of "Answers to 1001 Questions".

For the theory of sound there is *Science and Music,* by Sir James Jeans.

Books on musical appreciation, on the lives of the musicians, of the stories of the operas and of the orchestra and so forth, are very plentiful too; there it is largely a matter of browsing in the Public Library and pleasing yourself.

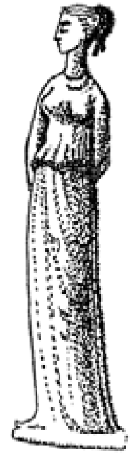
Penguin Books publish a periodic Music Review just as they do a Film Review, and also biographies of the great composers and a Song Book. They also have a series of "scores" for the more advanced music-lover.



CHAPTER XIV

MAN RE-CREATES

(Painting; Sculpture)



THIS chapter and the next are about what is usually known, quite simply, as "Art": the ability of men to re-create what they have seen and imagined, and to please—or startle, or at least profoundly affect—their fellow men by what they create. The theme throughout will be, one might say, the *universality* of art—the fact that Man can produce beauty almost always and everywhere if he tries. The trouble is, of course, that he does not always try; particularly since the Industrial Revolution he does not always try. . . .

That brings in the ordinary person, the layman, the *appreciator* of art. If he is blind to art, indifferent to art or lack of art, if he does not demand fitness and beauty around him, then men as a whole will *not* try and their potentialities will be wasted. No book can teach you to become an artist; but books can teach you to be a more live and knowledgeable and intelligent appreciator of art, and these chapters will try to make a beginning. We have already stressed in the chapter on Drama the importance of the appreciator's—or, if you like to put it that way, the customer's—role.

Now there can easily be too much talk about art, too precious talk, too highbrow talk. It is that sort of thing that antagonizes most of us and gives a feeling either of resentment or inferiority. To avoid that danger we shall in these two chapters be very simple-minded and simple, we shall assume virtually no previous knowledge. If we err on the side of being childish, or condescending, we make the excuse that at least it is the lesser of two evils.

Take first, then, a more or less scientific conception. Consider how we see and appreciate *movement*. Obviously, at any particular instant of time we must see the object as stationary. But that is not in the least the *impression* we get. What in fact our brain does for us is to combine a series of separate impressions: it "remembers" from one to the next, and so gives us the *idea* of movement. It is what in our Psychology chapter we called a subjective impression: it is not just simple registering by the eye, but something in which our own brain has come into play.

Yet the camera taking a photograph does not of course even begin to convey this impression of movement which our own eye achieves. Despite this, some unfortunate phrase-maker has befuddled us by that most dangerous over-simplification, "the camera cannot lie", and we have been foolish enough to believe it rather than believe the evidence of our senses.

Look at some photographs of movement, of horse-racing for instance, with a new and critical eye. See how stiff and queer they are. *That is not the impression that our own eye gives us.*

Who, then, can come to our rescue?

The answer is of course, the artist. The artist can do what the mechanical thing, the camera, can never do to the same extent, however skilfully it is used. *He can select; he can suggest; he can create an impression.*

We are using this idea of movement, of course, only as an example of what the artist can do. But let us take it a little further. In this instance what can he do?

The artist, to create the illusion of movement, can first of all do the obvious things, show the characteristic attitude, the attitude that is to say which we most easily recognize as one of movement because it is "held" longest by the mover. But he can do more than that. He can produce an impression of confusion and indistinctness where he wants it; he can reproduce actual distortions and inaccuracies which the eye "thinks" it sees. He can do more even than that. He can create the feeling of *rhythm* in his whole picture or sculpture. For remember that the eye of the viewer *travels about* a work of art; it can be made, then, to travel in the direction required, and quickly if quickness is required. Rodin, the famous French sculptor, even said that the muscles of that part of his piece which you naturally looked at later were actually portrayed as working later in time—adding incidentally that he did this instinctively and not of set intent. It is also true that the natural lines of a quiet restful picture are horizontal and vertical while those of a picture of movement and effort are usually diagonal. That somehow seems to give the required impression, perhaps because animals and humans do assume an angle to the vertical when they move and make effort.

We now carry the point about movement to a much wider aspect. We ask a question. Which does the artist do:

Copy Nature exactly; or
Create an impression?

We can answer it at once: *it is the second which he does.* The first ought in fact to be scored through with a heavy black line. The artist will not even try to do the first, because he knows he cannot. After all and at the very least, he is painting in two dimensions what he sees in three.

But does that strike you as a quibble? "Surely," you may say, "he at least paints exactly what he sees before him?"

The fallacy there is the assumption that the human eye sees completely and simply. One obvious example of this fallacy has been given: movement. There is also the matter of focus. When we look at something near, the rest is out of focus. It is the same with the camera; but whereas the photograph shows the background with equal emphasis but blurred, we in our vision simply ignore it. In other words, we in our seeing also *select*. We select in other ways too, much more than we realize. Our eye scans the scene; and something strikes us and we remember it, and it makes an emotional appeal to us. So does the eye of the artist—and since he is an artist, with a vision undulled by use and workaday practicality, he sees much more than we do. He sets down what has made an emotional impression upon himself.

Always that word "impression"! One simply cannot put it more plainly than that: the artist receives impressions, and tries—in whatever medium he favours, be it for that matter words or music or paint or stone—to get it across to you.

And do not forget that when we speak of Art we are in the realm of the imagination and the emotions, not of pure reason and the intellect. Why for that matter, then, should the artist stick to what he sees, why not also portray what he imagines? And then we must consider *pattern*. That is another thing rather like rhythm—you might almost say they were the same thing, in space and time respectively. Pattern is another fundamental thing in life, to which human beings by their nature cannot help but respond. Why should not the artist depict patterns then, why should he not introduce a sense of pattern into his work even when he is portraying real things?

Lay hold of that word *emotion* too, and the getting across of emotion. Art has been described as "emotion recollected in tranquillity". Another artist has put it succinctly this way:

"The artist's purpose is not to reconstruct nature, but to communicate his own emotion and interest to others, whether his art be realistic and imitative or an abstraction not recognizably connected with natural appearance."

Which means that the *prime need and duty of the appreciator of art is to understand and enter into the spirit and intention of the artist.* One may be critical certainly; but one should be tolerant, sympathetic, unprejudiced.

Now, few of us visit the art galleries and museums as often as we should. Let us, then, create an imaginary guide, let us put ourselves in the place of an ignorant but willing student, and let us see what happens. "Mentor" we will christen this guide; he is kindly and sympathetic, and possesses great enthusiasm. . . .

Perhaps your own enthusiasm is, to begin with, more than a little hesitant. You hang back because you have your resistances, because—naturally suspicious of the highbrow—you feel you need to be persuaded. "But," you say; "but, Mentor, what really have pictures to do with an ordinary person like me? In this modern age, when. . . ."

But Mentor impatiently does not let you finish—for let us make him reasonably human and not too much of a paragon. "It is not only pictures that I am going to show you," he says. "And as for your question, you can ask it again—if you need to!—at the end.

"We are going first," he continues, "to the National Portrait Gallery."

"Why?"

"Because I think you cannot help being impressed by the striking reality of what you see there: a sense of real live people, with character, with emotions, looking out from the canvases. You will be looking at the famous, of whom you have read in history. You will have seen reproductions of these pictures in your history books. Even the best colour reproduction cannot give what an original can give—it is a matter of surface, and of size, if nothing else. As for the average black-and-white illustration in a history book. . . ."

You are now standing in front of Hans Holbein's full-length portrait of Henry VIII. And you say, quite simply:

"Good Lord!"—or your favourite expression when surprised or impressed. For here is arrogance. Here is kingliness. And wilfulness; and the potentiality of terrible cruelty. Here is indeed a real man. So *that* was King Henry VIII, murderer of wives, murderer of ministers, tyrant of Tower Green, yet a man of parts, handsome in his youth—terrible in his old age! You see a smaller portrait, head and shoulders only. In that there is more of evil and less of kingliness in the face: heavy; fleshly.

"I will show you," says Mentor, "the noble and tragic Sir Thomas

Moore; and Bunyan, and Pepys, and Wren; and Cromwell and Nell Gwyn. *Are* those real people, and not lay figures in a history book?"

"They are!" you say humbly.

"One other, but not here. When we get to the Victoria and Albert Museum, have a look at the bust of Charles II. For sculpture can be as effective as painting in this direct way. Under his unnatural wig there is a lined, thoughtful, and very human and intelligent face.

"And one other thing while we are here, though we are shifting our ground a little: this head of Einstein by Epstein. Epstein's big symbolic pieces you are not ready for—you may never like them though you can hardly ignore them. But this. . . ."

You are before a head in bronze, rugged and rough.

"Bit different from a Madame Tussaud's Waxwork!" you say—and immediately feel you have been ineffably silly.

But apparently not. Mentor takes you seriously. "Better or worse?" he asks.

"Better of course!"

"Why?"

You have to think. "Well," you say, "you *see* something there. A man. A character. Einstein, I suppose, in fact: you can imagine that head inventing Relativity. But a wax model dressed up in real clothes . . . well it would be something dead, though superficially of course it would be much nearer the real thing."

"You are coming on!" says Mentor. "We will now go round the corner to the National Gallery."

"But there's so much we haven't seen here!"

"Little and often," replies Mentor promptly, "is the recipe for picture galleries. Even when it can't be often it should still be little. To cram in too much is like eating the last bit of bread-and-butter so as not to waste it! The result is indigestion, which is even greater waste."

"Yes!" you say dutifully; and find yourself in front of Velasquez's full-length portrait of Philip IV of Spain.

"What is the outstanding characteristic of that man?" asks Mentor.

"Pride!" you say.

Arrogance and assurance and kingliness stare out at you again. At the side is a smaller and a later portrait: perhaps a wiser, certainly a much sadder and gentler man; but still a king.

"So much," says Mentor briskly, "for bringing history to life. Now let me see if I can strike you hard in another way. I am sorry, but it means a pop over to the British Museum and back. Jump in this taxi! . . . ."

"There you are!" says Mentor. "As you have no doubt guessed, it is by a Japanese artist. Art is universal. It is called *Tiger by a Torrent*. Look well!"

You most certainly cannot avoid looking well. There curled up on the branch of a tree is a tiger. His form is silhouetted against the sky. But it has no hard edge to its drawing; only the patterning is brilliant.

Curled round towards you is its head. If the body is brilliant, this head is *shocking*. The green, baleful eye is enormous and fascinating. The fangs, painted in great detail—blinding white, some blackened—are the essence of all ferocity and rapaciousness. Below, far below, is the torrent; it is suggested, successfully, by a mere patterning in green and blue and black.

"Don't," says Mentor, "say anything, unless you want to—the imagined need to say something at all costs in an art gallery is a menace! Well, you remember Blake's poem:

> " 'Tiger, Tiger, burning bright
> In the forests of the night,
> What immortal hand or eye
> Could frame thy fearful symmetry?'

"Here you have the parallel in art. You have, have you not, been 'struck all of a heap'? You have been *impressed*. You won't forget that. That is, essentially: *tiger*. Next time you see a real tiger, you yourself will observe it with a more seeing eye—because a real artist saw it first, and has conveyed his impression to you. Ready?—come away, then! One last thing, though: note how much is *left out*. The Japanese and the Chinese are great at leaving out. . . .

"The Chinese," says Mentor in the returning taxi, "took art and the artist very seriously. They were apt to consider the spiritual and mental discipline and the necessary concentration which preceded the execution of a painting of more value than the actual application of paint. 'On a day when he was to paint, Kno-Hsi would wash his hands, and rinse his ink-well; he would put his desk in order and burn incense on his right and left, thereby calming his spirits and composing his thoughts.' He would then, apparently, contemplate, while fasting—and in the end perhaps paint not at all! Which is perhaps going a little far—though no doubt you see the point. Now for just one Italian 'Primitive'."

"Why only one?"

"Because I think a good many people have destroyed their liking for pictures, perhaps for ever, by doing what seems the natural and logical thing, and starting at the historical beginning of European art. Naturally they are not yet able to understand or appreciate the early Italian pictures—or the later ones much either for that matter—and merely become cross and suspicious at contemplation of any enthusiast who does."

You are now gazing at *The Nativity*, by Piero della Francesca, who lived in the fifteenth century. You do not know what to say, but are saved from saying anything.

"Stiff, angular, flat, queer!" says Mentor. "Unlifelike, Eh?"

"The faces are real. . . . It doesn't," you add, "look so old as some of the other paintings."

"That is because it is done in 'tempera'* and not oils—which is partly responsible for the flat effect. They had not learnt to paint in oils yet—there is in fact a lot they had not learnt yet. Come and sit down and let me talk about Italian art for a moment.

"Many will say that to study Italian art is the best way to study art in general, for the reason that here you have a continuous growth—you can *see* both knowledge and tradition growing. But I have told you: I think it dangerous. If on the other hand your budding interest has not been blighted, you will come back to Italian art of your own accord, and read about it—and come to find it perhaps the most rewarding and the most spiritual of all.

"For don't forget," continues Mentor: "the Italian Rennaissance was a truly remarkable time. Amazing! Art doesn't necessarily come with prosperity, by a long way; but perhaps prosperity is one of the necessities. Another is pretty widespread interest. In Italy that was certainly there! People were as excited about the result of an art competition as we are over a Cup Final. Why, some of the names which have come down to us are just the artists' nicknames: Donatello, familiar diminutive for Donato; Botticelli, the Little Barrel! Artists were not a race apart then, they were craftsmen like any other craftsmen—and popular heroes into the bargain. They had apprentices and 'schools'—real schools, which led to schools in the metaphorical sense, of ways and styles of painting. And the world was religious then—which is not necessarily the same thing as being moral—and so the subjects for picture and sculpture were nearly always religious. Obviously if you are going to appreciate Italian Art you have got to understand something of the outlook of the Italian artist. . . ."

Mentor gets up suddenly. "But something less difficult . . .

"There you are! Giovanni Arnolfini—not to mention his wife, though she doesn't come into the title—by Van Eyck. Painting in oils has arrived. The Flemish discovered it. And they had already a tradition of miniature painting. And so what intense and perfect detail! It is a favourite pastime here to lean across the barrier and observe that even those tiny medallions around the mirror in the background show

* Look in your dictionary for an explanation of this word.

each a small perfect scene. Oils could do that—so Van Eyck did it! This is an example not of leaving out but of putting in. It is admittedly effective. The background is there, perspective is there; but something in concentration and arrangement has not been learnt yet, attention is taken too much from the central figures.

"And now," says Mentor, "how much more can you absorb before I whisk you off to the Tate to finish your lesson on pictures there? Velasquez's self-adoring *Venus*, and Hogarth's adorable *Graham Children*? Not idolized children, the latter, not chocolate-box beauties, you see. But again: *children*. Or landscape? Landscapes are easy to delight in, though they come comparatively late in the history of art. Constable's *Flatford Mill* or *Cornfield*. See how he gets his effect of intense sunlight by bright splashes in an otherwise dark picture. He makes you dream of English summers? Let him then! And then here, what you might call 'city-scapes': Canaletto and Francesco Guardi; what to *put in* again—such detail as no human eye could ever appreciate at once, no camera either for that matter. An *effect*. . . .

"But what I want you to see last are two examples of *arrangement*. Of Pattern. Of composition as we call it. First, *Peace and War*, by Rubens. What a lot on one canvas! It might be sheer muddle. But see first how static and restful is Peace. Then your eye travels aslant to the turbulence, patterned turbulence, of War. And then—this way—France of the late nineteenth century: Renoir's *Les Parapluies*. Is that a muddle of umbrellas, or an *effect*? I will leave you with those two whilst I visit just one of my own favourites—not for you yet!"

Soon Mentor comes back. "I have been thinking," he says. "It is always the same—art should really not be talked about at all—I give, I am sure, an impression of artiness, of preciousness, however hard I try not to. There are two extremes of reaction to pictures. One is the 'Ooh, it might be real!' or 'I like that picture 'cos it tells a story!' and the other is to chatter about planes and patterns and atmosphere and beauty of form and all the rest. *And the last state is worse than the first.* What I want of you is that you should retain something of the first naive attitude *plus* a wider appreciation from knowing what is possible, what is intended, and what is achieved by the artist.

"So come, before we leave the National Gallery, to see one picture which is at once great and which yet 'tells a story'. It is by Rembrandt. Rembrandt, as do many of the Italian artists—Leonardo de Vinci, Michelangelo—will 'grow on you'. So the rest of Rembrandt's can come later. Here, however, is his *Woman Taken in Adultery*."

Now there we will leave the imagined Mentor, before his company becomes tedious; though his conducted tour has by no means finished.

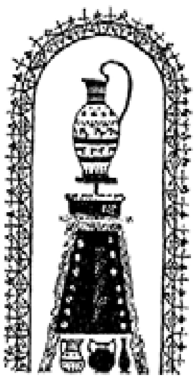
At the Tate Gallery he might well take the opportunity, while showing Hogarth's pictures, to get across an idea that needs care in the exposition lest it should lead to misunderstanding. *Caricature* is of course a separate form of art. But there is really no dividing line between that and much other art which uses legitimately an exaggeration, a heightening of effect here and there. In caricature itself, Low, the great cartoonist, can often make us suddenly see what some politician or public figure is really like with much greater clarity than any photograph has ever done.

But Hogarth, for instance, in *Marriage à la Mode* can create a sort of exaggeration or caricature of incident which heightens his effect. In one picture, while terrible commotions are going on, a lean cur in one corner has jumped through the window and is about to make off with a nicely roasted pig's head. The whole feeling of beastliness and ineffectiveness and underlying squalor which the series of pictures gives is accentuated by the incident. And it is a most exaggeratedly lean and squalid dog.

We should see, too, in the Tate Gallery many paintings by nineteenth-century artists of the so-called Impressionist School. We should be told to stand back, and enjoy their lightness and grace and remember that, after all, to give an "impression" is every artist's aim and that these painters have merely given themselves a little more licence to be the opposite of photographic. We might even feel that one day we shall begin to appreciate "futurist" and "cubist" and even more modern forms of self-styled modern art. Or we might feel the reverse—which would be a pity though not half such a pity as if we had failed to appreciate any art at all.

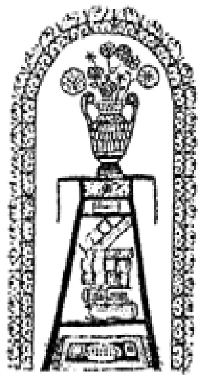
There will be pictures in other media to see too, water-colour, chalk drawings, wood-engravings, etchings; and any guide would take the opportunity to point out that to appreciate art one needs to appreciate the medium in which it is executed and the limitations and possibilities of that medium: water-colour for instance has not so great a range of light and depth as oils, but has yet a delicacy of transparency that the other hasn't got.

And there, because we have laid down the dictum "a little at a time" for art, we will finish a chapter. *Books* will come at the end of the next.



CHAPTER XV

MAN BEAUTIFIES



(Other Visual Arts; Design)

WE must approach now the idea of the universality of art from another angle. It is something which our imagined guide of the last chapter would find himself very able to illustrate at such Museums as the Victoria and Albert or the British in London, or for that matter in any good museum anywhere at all.

To put it naïvely and colloquially: what a lot of art there is! How surprisingly many things are on show in a museum as Works of Art! Almost everything is there, from mother's work basket to father's gun—or sword—or dagger—or whatever other sort of weapon he has used in the past; from the pot to cook in to the silver cup to drink out of; from the carpet under your feet to the jewel on your hand. Almost everything that anybody has ever possessed. . . .

That indeed is the word: possessions; Man's possessions, the things he has made for himself. *It is natural for Man to make things with skill, to perfection, and with beauty.* Heaven knows why it is so, but Heaven be thanked that it is!

When men make things in that way, they last after they are dead. And that, men found, was good. For people were remembered by the beautiful and clever things that they had made. In such a way *tradition* in art began.

Do not forget how strong and important tradition is in art. It must rightly be so. It can be too slavishly observed, no doubt; but the accumulated skill of generations is there, to be used and to act as a guide. Tradition is fundamentally just this: the way things have been done.

It is for this reason that the student will study so closely the history of art. We cannot do that here. But let us at least realize its importance—and, in passing, the importance not only of history to art but of art to history. Spend some time in a room full of Indian art, and you may be nearer to understanding Indian religion; follow the example of Keats and gaze at Greek vases, and the Homeric stories will seem more real to you. For that matter the archaeologist, seeking out history from the time when no one wrote it down, will go to what he can find left of the arts, the pottery and the jewellery and the harness and the armour, for his best source: there is even a Bronze Age people that is known by the name of its pottery, the Beaker People. (You can see something of their work in a small museum at Harlyn Bay in North Cornwall—and in the place in which they left it.)

Our museums—and our houses too sometimes—are full of the beautiful things which have been made in every place and in every time. What should be really surprising then, is that we of this generation should in fact register any surprise that nearly everything of everyday use made by man has in the past been beautiful and has had skill and imagination and hours of loving care spent upon it. We are surprised, purely and simply *because we live in a machine age.*

Now let us be careful! Do not let us slip off into a diatribe against the ugliness of a machine age. Do not let us become superior and "precious" and be betrayed into exaggeration! Much that is produced by machinery is not ugly; the lines of a motor-car for instance can be very graceful. Much that is produced by machinery is, if not beautiful, at least straightforward and fit for its job.

Nevertheless, much—because it is often so fatally easy to produce by machinery—is indeed ugly, and much is not even straightforward and fit for its job.

And the results of this, if we are not careful, may be disastrous. One result could be sheer universal ugliness—and that can hardly be good for our souls; a few of us would be dilettante and the rest insensitive and brutish. Another result might be a frightened retreat from all the blessings which machines can give us. And a third result may be a totally wrong conception of art.

That last is already partly with us, and we, the educated, need to be aware of the danger. The *wrong* conception is of art as something separate from things that are made and merely stuck on afterwards—as opposed to something which should be inherent in every good thing made. We allow facetiousness and silliness to creep into our homes: an umbrella stand made to look like the hollow branch of a tree or some other monstrosity. Or we desperately copy a style and tradition of the past, because we have not one of our own, and try to fasten it on to the new without realizing the absurdity of, say, a "Sheraton" radio set or—to trespass into architecture for a moment—a "Tudor" house where the solid wooden beams which should be there for real work and real purpose are thin boards nailed on or are merely copied in ferro-concrete.

There is much too much of the sham and the *pseudo* about—and it will go on being produced until we show that we do not like it. All this did not happen in earlier ages, not because they were better ages but because things were made by hand and were made directly by the craftsman for the user. If in Tudor times you had wanted an oak chest you would have gone to the carpenter or cabinet-maker of your village and asked him to make you one. You would have known how it was made and what you wanted; you would have probably seen it in the process of making. He—with the skill and understanding of a craftsman—would have made you a chest that was a chest and looked like a chest and gave you the service that you expected from a chest. But nowadays you do not see a thing made and probably do not know how it is made—and the Company that makes it may be more interested in catching the public eye (and a quick profit) by a "novelty" than in producing something plainly and honestly fit for its purpose.

We have arrived in fact at *design* and the importance of design. It is important that everyday things should be fit and proper for their use and should please the eye and the aesthetic senses by their appearance. It is important that their users should have a good eye and a sound aesthetic sense and should not allow themselves to be fobbed off with the unsuitable, the unserviceable, and the second-rate.

But how are we to develop that good eye and sound aesthetic sense? It would not be wholly untrue or too ridiculously optimistic to say that we all have them naturally if only we permit them to function. The rest is largely taking the trouble to see what has been beautifully produced in the past. Many of our great houses, filled with their lovely possessions, are open to our inspection—from royal Hampton Court, one might say, downwards. Our museums and art galleries—this cannot be repeated too often—are full of lovely things. Perhaps from such a visit one thing only will stay in your mind—some great stately carved bed or some delicate, exquisite Chinese bowl—but that will stay with you, always, and your standards will be altered.

Nor is it essential to have a great knowledge of the styles and schools and trends in the history of the arts. If you are interested you will no doubt learn all this—there are plenty of books to help you—and you will be likely to find it fascinating. You *may* of course become in the process an artistic snob—and that will be purely a tragedy of your own character. But you will do well enough if, to begin with—and besides holding on to that natural integrity we have spoken of—you realize one great point. It is this, that a style in art is a *natural product of its time.* It is a product of what men think and feel, an emanation of their spirit; a result, in things that you can touch and see, of their history. As an instance, there was, about the time of Napoleon III of France, a great revival of interest in the ancient classical world, set going largely by new archaeological discoveries therein. It influenced not only architecture, but decoration, furniture and furnishing, women's fashions. And the word is with us still, *Empire,* because Napoleon III's reign was known as the Second Empire of France. That of course, one might say, was in itself a copying of the past; but it was not a dead and slavish copying but a reawakening into something new and genuine from an enthusiasm engendered by the past, a very different thing.

So much—so very sketchily—of the Visual Arts other than the more formal and easily recognized ones of painting and sculpture. Now let us shift the ground entirely to *Reproduction*—the reproduction, that is to say, of pictures.

Here again the first thing to notice is that modern methods and modern ease have rather hidden the problem for us and sometimes perhaps vitiated our taste. By modern methods we mean, essentially, photography. Do not let us be unfair here. The photographer can of course be an artist—any exhibition will show you that. He too can select, he can suggest, he can create an impression. But what we are thinking of, rather, is the mass of everyday photographs of the popular Press. Those, too, no doubt, are often clever; but they are often harsh and crude, and they are usually—by comparison with the best that is possible—crudely produced. The pity is, that to very many people that type of "picture" is the only one which exists.

To the people of pre-photograph days reproduction was a very real problem. They solved it in many ways—and produced, one must realize, some new and very lovely forms of art in the process. What was wanted, one may say, was to take the picture of the people, rather than depend upon the people to come to see your once-and-for-all-painted picture. It would be a great advantage to be able to *multiply* your picture.

Think first of book illustration. How was that once done? The answer is, of course, by hand: the mediaeval missals and Books of Hours, devotional books, were both illustrated by hand and written out by hand. Each process was an art. (And lettering for that matter still is an art even though the ordinary person hardly takes the trouble to realize that there is anything more than one way to set down the letters of the alphabet.)

In due course the *printing* of books arrived. And what about the illustration then? For that matter, what about the painted picture—could not something be done about this too, to produce more than the one and only copy?

It could of course, and it was. The answer—the answer before the photographic process came to change so much—was the woodcut, the engraving, the etching, the mezzotint, the aquatint, the lithograph.

There is so much to be said about all those processes, but the scope of this book will allow us to set down no more than a few, a very few, fundamental ideas about them.

There are really just three methods of reproducing pictures. These are usually called :

The Relief print,
The Intaglio print,
The Plane print.

The first is exactly the same as printing words and letters : you take a flat surface, cut away what you don't want to show black, smear the rest with ink—and print. These are the wood-cuts and wood engravings.

The second is the reverse idea : you score lines into your flat surface, press ink into these, wipe the rest clean—and, when you print, it is the lines you have cut out that show dark. These are the engravings on copper and steel, and the etchings in all their varieties.

The third is the lithograph or printing from stone : more of that shortly.

It is probably true to say that many people are nowadays put out of sympathy with wood-cuts by the specimens that they see occasionally as illustrations in books. These are often, shall we say, *mannered*, because, some form of photographic method of reproduction being so much more usual, they are likely to be rather special and precious and selfconscious. But the making of wood engravings and the printing from them is a very real and lovely art, with effects of light and dark that can be achieved in no other way.

That is true in fact of all these ways of reproduction : invented first as methods of printing or repetition or, as we might say, mere multiplication of an original, it was discovered that they were beautiful and a distinctive art in themselves, each with its limitations and possibilities. That is why—to turn to the next type, engravings and etchings—you will often see at the bottom of the picture "pinxit, so-and-so" in one corner and "fecit" or "sculpsit, so-and-so" in the other. In other words, one person painted a picture, and another reproduced it as an engraving—and the second person was as much entitled to be considered an artist as the first. Of course this did not mean that a man might not reproduce his own picture or—particularly with etchings—that the whole thing might not be an original rather than a method of reproduction.

Now what is the difference between engraving and etching? The fact that the word *etching* is of the same derivation as *eating* gives us a clue. Whereas in engraving you actually gouge out the lines that are going to take the ink, in an etching you let an acid "bite" out the lines for you. In practice you cover your copper plate with a coating of something that resists the acid, and then merely remove this coating—with an etching needle—wherever you want your inked lines. The great advantage of etching is that you have more latitude. You can put your plate in the acid for only a little while, then "stop out" some of your lines, and then put the plate back for a deeper biting process and deeper lines, and so on. You can do other things too. There is the mezzotint, where by a special process you get a lovely velvety-black surface—our own Prince Rupert, nephew of Charles I, is said to have introduced that into England and to have been inspired to the process by the inner surface of a gun barrel! Aquatint gives an even softer effect—and here the "tint" is not a matter of colour but of getting the equivalent of colour by an expanse of "tone" as opposed to edges and hard lines.

Finally the lithograph. This is a most ingenious idea which makes use of the antipathy of fat to water. You take a slightly porous and absorbent stone of a certain type, and where you want it to print you draw with a greasy crayon. You then damp the whole thing, and roll on to it a greasy sort of ink—which only stays where you have used your crayon. Lithography gives an even softer effect than aquatint.

And then along came photography, and altered everything—not necessarily for the worse, but altered it most definitely. The sun was harnessed to do automatically what the hand of man had done before. The photographic methods of reproduction are many and too complicated to be described here. There are the photographic equivalents of all the hand processes, wood-cut, engraving, etching, lithograph; and all depend on the same thing: that by the use of certain chemicals a surface can be made to vary with the amount of light that has fallen on to it, though here the variation is not merely lightness and darkness but the ability to *print* lightness and darkness. The most usual method is to produce a block to print from—the so-called half-tone block, though "varied-tone block" would be a better name—by use of a fine mesh "screen" which divides the thing to be copied into tiny squares each of which prints with a proportion of blackness from nought to a hundred per cent. That, in a coarse form, is our ordinary newspaper reproduction—and you can even see the coarse grain of it sometimes with the naked eye.

Colour printing can vary from an equal crudity to the nearest in subtle exactitude that mankind has ever yet achieved—though do not forget that the best reproduction of an oil painting or a water-colour can never be more than a poor substitute for the real thing.

Finally, this chapter will end, as did the one on Music, with a few definitions. Though disconnected they are not taken at random; they represent the terms most likely to cause a feeling of inferiority on the part of the layman: they are often used but their meanings are by no means obvious.

1. *Perspective.* This is the effect that distance has on the way we see things. It is a science, and it is not simple; optics and geometry come into it. The artist—who has to delineate in two dimensions what is seen in three—will not scorn this science, any more than he will scorn the science of human anatomy. Both will help him to draw and paint more accurately and more understandingly.

2. *Atmosphere.* Unless this term is being used very generally and metaphorically it means exactly what it says: getting into painting, etc., the effect on distance that is made by our atmosphere or in commoner words the air around us. When we see things through a lot of air, or misty air, or evening air, it looks different—blue mountains in the distance and so forth. It is as it were a "perspective of colour". If an artist has created that effect well he has created atmosphere. The early painters did not worry unduly about either atmosphere or perspective.

3. *Chiaroscuro* (Pronounced with a K). An Italian double-word which simply means light-*and*-shade. One might say: depicting shadow skilfully. Rembrandt was a master at it—and his patrons didn't like it.

4. *Fresco* has come to mean, painting round the walls, or the top of the walls. It is largely what the Italians did; and their method was, you remember, to use "tempera" colours on plaster. The plaster had to be damp and *fresco* (fresh). Nowadays we are timid about painting our walls—though to leave them bare is at least better than using a spraying machine in whirling or ghastly angular designs.

5. *Pre-Raphaelites.* A band or "school" of British Artists—Millais, Burne-Jones and the rest—who in 1848 revolted against the commercialism and artistic blindness of their age and swore to paint and work with the integrity that had animated the artists before Raphael, in other words in the mediaeval Renaissance. Their style of painting—which we might nowadays call over-photographic—is not so important as their influence, which extended to stained glass, wall-papers, textile design, book production. William Morris was their literary exponent.

6. *Sur-Realists.* We have said that the artist's job is to create an impression, not to copy Nature. These people have taken this idea as

far as it will go, if not further. At the risk of being unfair to them, it is well to remember that the photograph—not to mention that nearly everything seems to have been done well already—makes it rather difficult nowadays to attract attention by one's art. Artistic experiment should not be taken with too much deadly seriousness. . . .

BOOKS FOR THE LAST TWO CHAPTERS: The ideas at the beginning of the previous chapter are taken very largely from an introduction by L. D. Luard to a book of his own paintings published by Cassells in 1921 and called *Horses and Movement*. Mr. Luard is an Englishman but of French extraction, who worked mostly in and around Paris, where he loved to paint the big strong Percheron horses in action. It is unfortunately not an easy book to get hold of nowadays.

An Introduction to Italian Art, by Sir Christopher Holmes (Cassells again), is very well designed for beginners—as is *An Introduction to European Painting*, by Eric Newton (Longmans). Then there are good practical chapters on all forms of art, and a superlatively good introduction, in *The Arts, Man's Quest for Beauty*, published by Odhams in 1935. *Etching, Engraving Etc.*, by H. W. Singer and W. Strang, will probably tell you all you want to know about reproduction even though the book was published (by Kegan Paul) so long ago as 1897. Much more modernly, there is a children's illustrated *Puffin* book on colour printing. So far as reproduction of pictures goes, nothing can really compare with the originals, yet many originals are a long way off. The *Phaidon Press* Books—big and expensive but to be seen in most good public libraries or reading-rooms—are about the best in their class.

For the history of art try to get hold of *Art Through the Ages*, by Helen Gardner (Bell), a fine book finely illustrated.

CHAPTER XVI

MAN THE BUILDER

(Architecture)

"WHY all this fuss about 'modern' architecture? And have I got to like it?—because I don't think I do!"

Forget all that for the moment. We shall come back to it in the end, and appreciate better why there really is such a thing as modern architecture, and why it is perhaps right that there should be a fuss made about it, and what we are going to do about liking it.

Turn, first, to something which will surely seem easier, pleasanter and more romantic. Think of some picture you have seen of the great towering, impressive architecture of ancient days: the Acropolis at Athens perhaps, as it once was; or Karnak of the Egyptian tombs and temples, or perhaps even one of those throne-altars of the King-Gods—Ziggurats they were called, "Towers of Babel" perhaps—which were erected in the world's first city-states. Think of it not as a dead and ruined building, but as *in use*—a picture of life, colour, mounting excitement and surging crowds. Worshipping crowds, no doubt they were. For we must remember what psychology and anthropology have taught us, that mankind loves symbolic ceremonies and to take part in those ceremonies, feeling as he does that he is a part of the society that has invented and is enacting them.

That means, then, that the architect is the greatest artist of them all, or at least the artist that has influenced most, and most directly, the minds and hearts of men? That almost certainly is true.

"But I thought," one might say, "that the architect is the man I call in if I am lucky enough to be able to build a house, someone who knows about such practical things as stresses and strains, and draughts and drainage, such homely things as lights and lavatories, and warmth, space and shelter!" That again is true.

We reach then, it seems, a contradiction?

But that is not so. A paradox it may be perhaps, something that needs explaining; but more than that, no! After all, remember those Renaissance Italians who enthused about art; they made no distinction between the craftsman and the artist, except perhaps in degree—to do that is a modern idea. Remember that the painter, as we have said, needs to know much about the sciences of perspective and anatomy, and light and colour. Similarly the architect is no less of an artist if he can use mathematics to calculate the breaking strain of a beam or where to put a buttress; and he will certainly be a better architect. And even a palace has to have lavatories—some of the older ones would have been better if they had had a few more.

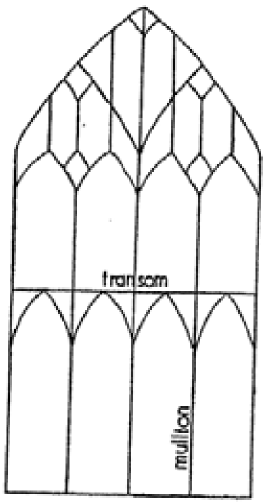
The architect in fact is the maker and designer of buildings; and a building is anything from a hut to a temple, from a bungalow to a cathedral, and nowadays from a factory or a railway station to a health centre or a concert hall. And those buildings can and should be beautiful and at the least fitting and effective. They should not be ugly.

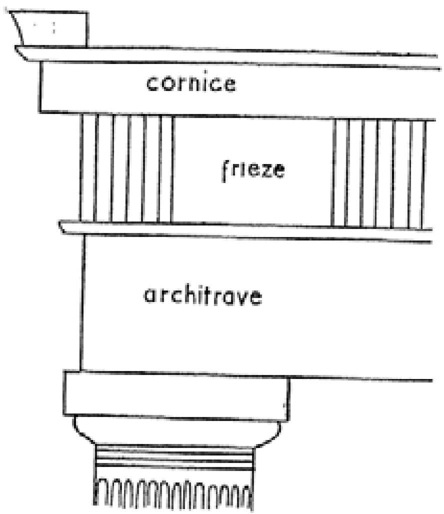
That is really the next point. It should indeed be obvious enough. But we have the nineteenth century and the Industrial Revolution behind us. And so, amazingly enough, we most of us need to have it rubbed into our consciousness: *buildings need not be ugly.*

We in this generation—and the generation before for that matter—go about not expecting buildings to be beautiful and so hardly ever thinking about them or looking at them at all. That needs to be realized: that the last hundred years or so has put both architecture and the appreciation of architecture into a very peculiar, and a not very happy position. One cannot imagine the Athenians of the time of Pericles, or the Venetians of the time of their Doges, being unaware of their buildings. On the other hand, one can very well imagine the present-day inhabitants of Bootle, Blackburn or Bolton—or a hundred other commercial and industrial cities, to be fair to those unoffending and very useful places—being only too glad to be unaware of the large majority of their buildings. . . .

That is the idea that leads us to the importance of, and the need to know something about, modern architecture and its problems. But once again we must leave that for the moment.

The teaching of architecture to most of us has probably been little more than something about the three types of Greek pillar—Doric, Ionic and Corinthian—and something else about the periods and styles in English churches—Early English, Decorated and Perpendicular. That, no doubt, all seemed rather dull and unreal to us, and probably we can never remember even so much with ease, and every time we look at a nineteenth-century town hall or a fifteenth-century church we feel vaguely worried and at a disadvantage. What perhaps we feel we would prefer to know is something of how people have set about building; of what, for instance, are the problems of the arch and the beam and the buttress, and just what is meant by such everyday terms as transom and mullion and architrave and cornice. (For answer, see the illustrations.) "All that," we most of us say to ourselves, "is admittedly not architecture, but I do not believe I shall ever understand or be interested in architecture until I know."

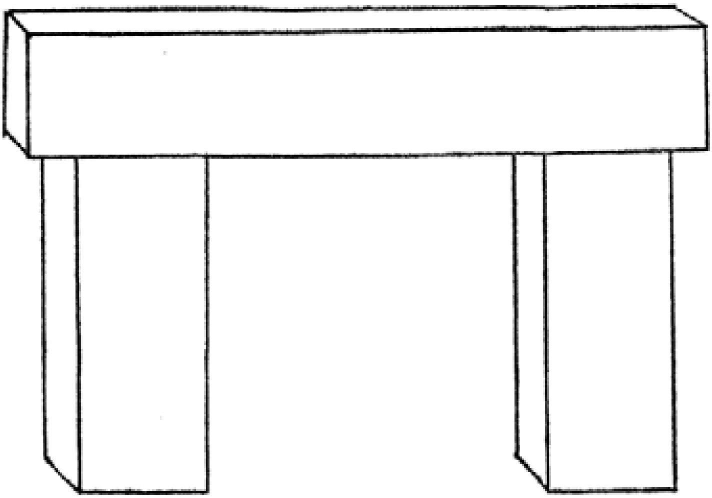




All of which would be very sensible of us. For no one likes taking things for granted. If we are to be told that no building need be ugly and that many are beautiful, then we want to know why that is so and both how beauty has been achieved and how we are to recognize it.

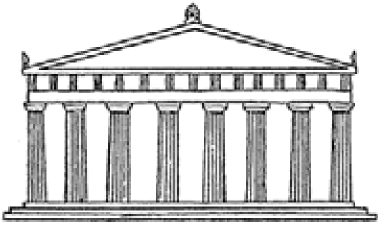
That brings in the history of architecture. So far in these chapters on the arts the history of them has been avoided, for it is so easy to slip into the dull academic way and to talk of nothing but styles and influences and schools and the like. But now it seems necessary: a sketch, then, of how men have learnt to build successfully and effectively and beautifully.

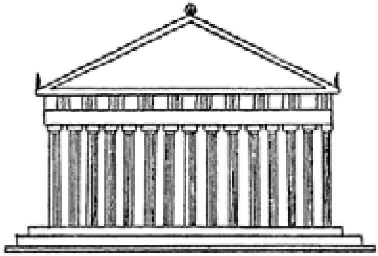
First the Egyptians. We have carried over from them the post-and-lintel idea: two uprights and a slab across. It is a very simple idea—it is older than Egypt for that matter and you see it in Stonehenge. But it is solid and strong and imposing. Particularly is it impressive as an entrance, with two very massive posts or *pylons* at the sides.



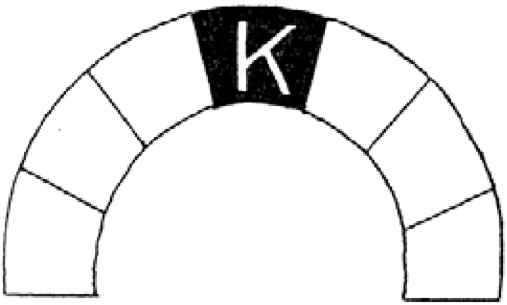
Prehistoric Post and Lintel

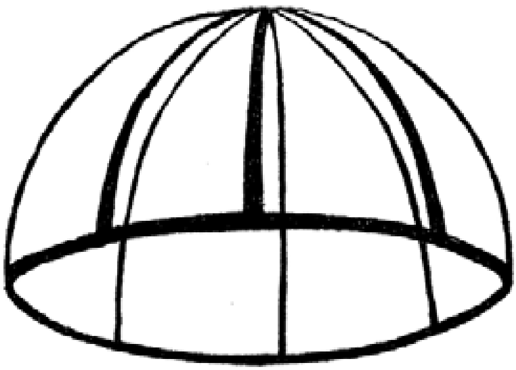
But why make those pylons quite so massive? Make them into pillars or columns. And why only two columns? That is the Greek contribution—that and an eye and skill for beauty which produced the Grecian temple, with its rows of graceful columns surmounted by the cornice and the frieze. *Why* were the classical Greek temples beautiful? They were enriched with beautiful sculpture. But we know that it was more than that. They had grace and they had *proportion*. There is no good way of describing proportion; you don't describe it, you *feel* that it is right. (Again the illustrations may help.)





Now those many columns had a practical use as well as an aesthetic; there is a very real limit to the length of unsupported slab or lintel that you can put between your supports, particularly if you need to put some weight on top. The Romans, however, wanted wider space; they wanted to build mundane and practical things such as aqueducts and large circuses or theatres—Colosseums and the like—for the teeming and sometimes discontented inhabitants of their cities. They developed the *arch*. There you use a semicircle of wedge-shaped stones, each fitting into the other and supporting the other, and with the weight only wedging them the more firmly. It is not so easy to build, because you have to support the whole thing as you build it until you finally fit the *keystone* at the centre. But you can do a great deal more with it than the mere uprights-and-one-across.

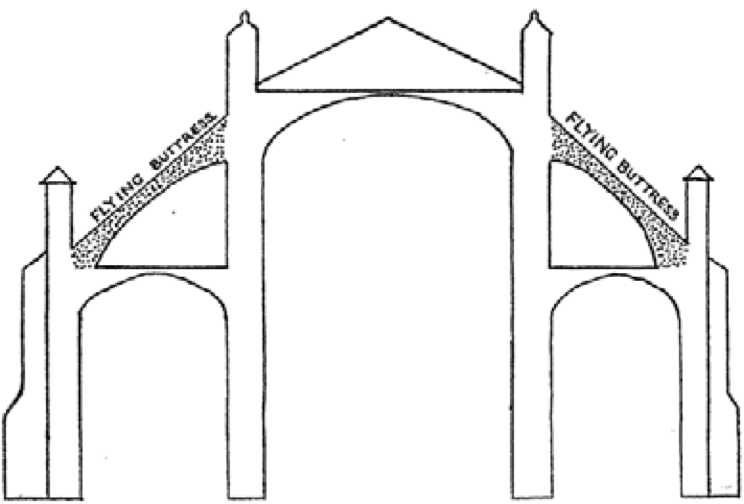




From the arch came the vault and the dome, which are, one might say, the result respectively of adding one arch alongside another or of spinning an arch on its axis—the difficulty whilst building and the advantage when built are both inherently the same and both multiplied. When the Roman Empire split it was the East and Byzantium which adopted particularly the dome, a tradition to be taken over by the empire of the Caliphs and to become the typical feature of the mosque.

In the West the rise of Christianity was followed by the pall of the Dark Ages. Slowly and clumsily Greek and Roman architecture was copied and adapted to new needs. Gradually, but then with increasing pace, there was evolved a new architecture, a new way of building, which has been given the name of *Gothic*. (You remember that the Goths were one of the Northern barbarian peoples who overran the empire of classical Rome.)

Now it may be all very well in Egypt or even in Greece to have a flat or nearly flat roof. But in rainy countries you need—unless you are very clever with drainage and impermeability of materials, which we are nowadays—a sloping roof. That creates, or rather accentuates, problems. If we had been able to follow Statics and Dynamics further in our chapter on Physics we should have learnt more about "lines of force" and how to calculate them. The mediaeval builder learnt about them—perhaps at first by bitter experience. He learnt that the weight of a roof has an *outwards* thrust on its supporting walls. There are two ways of curing that; one is by sheer blundering solidity, the other is by



buttresses. The Gothic architect preferred buttresses. He preferred them because he was striving for the very opposite of squat solidity; his idea of a building dedicated to the worship of God was something that soared and that lifted the eye to Heaven. In fact, he went further and invented the *flying buttress*, which can give you just enough support and be graceful and slender in itself. It has been said in fact that the Gothic building stays up not by solidity but by balance. It is the vertical idea brought to perfection, as the classical Greek is the horizontal. They were built too, these Gothic churches and cathedrals with their towers and spires and pinnacles, at a time when religious consciousness permeated the Western world. They really were works of love; and so the artisans and craftsmen engaged upon them—though no doubt they were very human people and liked their wages as much as any man—did spend a lifetime of skill in moulding with their hands and their tools a marvellous elaboration of *ornament* such as no other style of architecture has ever seen so successfully adopted.

And then came the Renaissance, the age of discovery and of new secular learning, and it slowly changed the face of the civilized world. But first a few words about the house as opposed to the church. Of course houses were being built in mediaeval times; it is simply that the stress and accent and importance is on the ecclesiastical side, a stress which now begins to disappear. Only now does the house begin to have much architectural significance. Before, one might say, it had been merely either the fortress-castle or the hut-hovel. The peasant was content if he could keep the heat in and both the rain from above and the damp below well and truly out—and even that needs some knowledge and skill. The castle was solidity—for safety's sake—gone rampant at the expense of everything else. But people by now—roughly by Tudor times in England—were realizing that it was possible to build a beautiful and comfortable home and to let keep and moat and drawbridge and slit-window and the rest go hang. The result was the "half-timbered" house—the house, that is to say, not built entirely of wood—which still remains about our countryside and in our older towns to delight the eye.

Back to the main trend. The Renaissance brought the glories of Greece and Rome once more very much into men's minds. Architecture was influenced accordingly, though there was no slavish copying. The dome and the pillar and the horizontal line came back; a reaction against overmuch ornament came too and with a "classical" severity. The change started in Italy and reached this country a good deal later, when the iconoclastic Puritans (please and if necessary see the dictionary—a useful and resounding adjective!) had made way for the later

Stuarts, and when Inigo Jones and Christopher Wren (who built much more than St. Paul's) were given at least part of the chance they deserved.

Two names of style now come up which are apt perhaps to confuse and worry us because there are few examples of them in this country: *Baroque* and *Rococo.*

They are both, we may say, variations of the long Renaissance period in architecture and are both revolts against ultra-severe classicism. People cried, "Let us have a bit *more* ornament and romanticism again!" The people who said it were often the rulers and great ones of those turbid centuries in post-Reformation Europe. Sometimes the churches that they caused to be built, and more often their palaces, were produced with a gorgeous lavishness so exaggerated that it has to be seen to be believed. Baroque is a Portuguese word for a misshapen pearl, and Rocco is roughly the same word as rockery—which perhaps gives you some idea of the general effect. Naturally architectural styles often influence the styles of the furnishings that the buildings contain; and the word "rococo" particularly is also used to describe such things as hangings, fittings, mirrors, ornaments of the period (or their imitation), suggesting something un-plain, often intentionally unsymmetrical, and generally romantic and elaborate. Listen to this description:

> "A peristyle [court] of pierced and sculptured columns, treated as delicately as lace. . . . A large, dimly-lit hall, from the depths of which will be heard the murmur of a fountain. . . . Everywhere paintings in the most vivid colours. . . . Draperies of the softest pale green. . . . Windows of the clearest aquamarine crystal. . . . Sofas, richly furnished with cushions, covered in white muslin relieved by raspberry colour. . . ."*

That was written in the second half of the eighteenth century by Prince Potemkin, favourite of Catherine the Great of Russia, when planning a house for one of his mistresses. He had, it will be seen, large ideas.

England however, as one might guess, was not much bitten by this bug of extravagance—George IV's exciting and fantastic Brighton Pavilion perhaps represented the nearest approach to it. England preferred on the whole to stick to downrightness and classicism, and developed the *Georgian* style: the long, plain-fronted house or mansion, relieved perhaps by fanlight and fine pillared porch and a well-planned line of windows. It is satisfying, and sound, and unfussy and aristocratic

* Quoted in *Four Favourites*, by D. B. Wyndham Lewis.

and severely beautiful. Again why? And again, largely a matter of proportion.

The New World comes into the picture now. It would not be too inaccurate a generalization to say that the Georgian style penetrated into North America and the Baroque into the South.

Then—after a kind of see-saw of alternating Classical and Renaissance "revivals"—there comes the Industrial Revolution and the Machine Age, and a lapse and a break in the so far connected story of architecture.

As we have already said, we must get it very clearly into our heads why there should be this break if we are to understand both why in the last few generations men and women have been so distressfully unaware and careless of architecture and why there should so very definitely be a new or modern architecture coming along. It is of course a particular aspect of the idea enunciated in the previous chapter: the malign influence of the *ease* with which machinery makes and copies.

The machine did two things. Firstly it caused that swelling of the population and herding into towns, that hard utilitarian push and scramble for wealth, that we read of in our history books. The "dark Satanic mills" and the slums arrived: one gets the impression that people felt grimly in those days that you couldn't *expect* wealth and production without ugliness. Architecture was likely to have little chance in that atmosphere. And then secondly, there was this dangerous and tempting copying facility of the machine. The cultured minority found themselves turning their eyes in despair from the ugly present and studying the achievements of the past. And so we get what somebody has called "architecture in fancy dress". "What 'style' shall I have my house in?" said the rich man. "Gothic? Roman villa? Swiss chalet? Mediaeval castle?—yes; then I can call it 'Castle So-and-So'!" —and he put his tame architect and the tamer machine on to the job. Ornamentation could in particular be copied. What the Gothic craftsman had done lovingly with his hands was ordered by the gross from Stoke or Birmingham. The machine can be used to help build beautifully—at least that is what we are nowadays beginning to think—but its way is not the way of applied and easily multiplied ornament.

Nobody is going to pretend that there was no good architecture produced in the nineteenth century. But undoubtedly architecture was in a bad way. It was knocked sideways, it didn't know where it stood. . . .

A new beginning had to be made. It came roughly at the turn of the century but did not really gather way until after the First World War. It had two new materials to help it. Those were: Constructional Steel, and Ferro- or Reinforced Concrete. The first of these comprises steel girders of a particular cross section, which have a quite colossal strength when bolted together. With these, so long as you keep to a rectangular layout, you can create a building of almost any size or height and to which the walls are merely a skin or covering, themselves bearing little or no weight.* Ferro-concrete is best explained in terms of something done to concrete. Concrete is itself a wonderful invention, though it is hardly new, since the Romans used it. It is a sort of artificial stone, made by mixing sand and cement (which is lime and clay burnt together) with pebbles or coarse gravel. Now that, rather like stone itself, is very strong in one way but weak in another. It is virtually uncrushable, it will stand almost any direct weight; but when it comes to a strain pulling it apart, it is a different thing altogether. That beam or lintel of the Egyptians and Greeks for instance: if you put a heavy weight in the middle it will tend to sag and bend. In other words there is compression along the top of the beam or slab, and tension—pulling apart—along the bottom. The invention of "reinforcing" concrete is almost literally to tie it together; it is done with steel rods, sometimes hooked at the end. In this particular instance, you imbed your steel rods near the under side of your beam; and the result is strength almost equal to steel. Nor are you, of course—for that is a simple example—limited to rectangular shapes, but can in fact produce something strong in almost any shape you like (though the necessary calculation of where to put your reinforcement may be a difficult one).

And so we get back—after so long, after the last really great idea, the flying buttress, one might say—to quite new possibilities in building because of new inventions.

They are very big possibilities. That is perhaps why we often dislike modern architecture: the fault may be either in us because we cannot adjust our ideas and sense of fitness rapidly enough, or else—oh yes, there is no doubt about this!—with the architect because the new possibilities have gone to his head and he cannot think of much beyond reacting violently to the lack of originality of his predecessors.

Functionalism is the modern's great word. "Let us start from the beginning and with no preconceptions!" they say. "You want a theatre built, for instance. Then let us forget what theatres have looked like in the past (like second-rate palaces perhaps?), and say, 'we want darkness in the auditorium and great height (for scene shifting) on and behind the stage; very well, we will build accordingly'. And *because we build accordingly* we shall produce something fine and even beautiful."

* Le Corbusier, perhaps the most famous of modern architects, is building (1949) a huge block of flats in Marseilles. He likens it to a "gigantic bottle rack"—a steel rack into which you drop not milk bottles but prefabricated flats.

Now that is obviously a theory not to be taken too far, and no doubt in their enthusiasm some modern theorists have taken it too far. But equally obviously it has a lot to be said for it, and can with profit be thought about a great deal. Perhaps indeed the great thing for the ordinary person is not to be put off by this brashness and enthusiasm and revolt and experiment, but rather to realize that architecture has at any rate woken up again and has some wonderful new materials to wake up to. We shall not always like the new—it may indeed be *bad*—but we must give it a chance and try to banish our preconceived notions when we see it. It is often very exciting, and nearly always (and at the least) clean and bright and forthright. Its apologists and defenders claim that it has a "poise and lightness", and they are probably right. What we, the amateur appreciators, need to do is to avoid the two extremes, of liking something old *because* it is old, and of liking something new merely because it is new. That will take us quite a long way.

The rest is mostly a matter of being interested, of getting to know, and of *keeping one's eyes open*. If we look at books about architecture we shall frequently come across a picture of some building which we see often or even pass every day, and we shall be surprised to find it cited as an example of this or that in the history of the art. Then we shall look at it again, with new eyes, and perhaps wonder that we have never taken any interest in it before. . . .

Mr. C. Williams-Ellis, who has written much about architecture, suggests in a chapter written for children that they should "question" buildings, and seek of course to give the answer themselves. Look at a building, he suggests, and ask: are you practical and fit for your job (Functionalism); are you well and soundly built; do I, and did those who made you, think you beautiful, and if not why not; what is there special and striking about you; and lastly, do you fit in with your surroundings? All that is surely good advice for grown-ups as well as children.

The last of those questions we may consider a little further, for it is an aspect we have so far ignored. One way in which a building will fit in with its surroundings is if it be made of the local material, Cotswold stone in the Cotswolds for instance. A way in which it will outstandingly not fit is if it break away ridiculously from the tradition which the geography and history of the place have created—a red-brick villa dumped down in a village of thatch and whitewash.

A building should be well mannered enough to fit in with the other buildings around it. It should not be discordant with the scheme and plan of the town it is a part of, any more than a member of a football team should start playing the wrong way of the field.

. . . . .

We have arrived in fact at *Town Planning*—and with it we shall briefly end the chapter.

The *details* of town planning we must leave to the expert. But remember this: the expert is *only* the expert, and being such his expertness may well run away with him. He usually needs a wise and knowledgeable layman to keep him on the rails. It is at least the job of the reasonably educated person, therefore, not to be prejudiced about town planning. He will perhaps say, particularly if he is politically that way inclined, that the less planning we have the better; and certainly it is not in the nature of the human animal to like to be bossed around. But on the other hand one should remember a few simple facts. They are these:

(1) Towns have always been more or less planned, unless on the other hand they have had the luck to grow up slowly and gracefully and naturally; the planlessness of our Industrial Revolution was a very peculiar tragedy.

(2) A town is for the benefit of its community; and there is a natural limit to its size, beyond which it is not easily a benefit; colossal cities are more of a mistake than something to be proud of.

(3) Modern traffic has altered things; we need then to alter or at least to question our accepted ideas. Is it, for instance, natural or reasonable to build one's house each side of a traffic way?

(4) Just as the house-planner must not ignore the town around his house, so the town-planner must in his turn pay due attention to the regional planner.

BOOKS: The children's book referred to, in which Mr. C. Williams-Ellis wrote a chapter on architecture, is *An Outline for Boys and Girls and their Parents*, by various authors and published by Gollancz in 1932. There is much in that book for a grown-up whether he be parent or not—it will be referred to again. If you don't mind feeling humble you will probably also enjoy *Architecture for Children*, by Jane and Maxwell Fry (Allen and Unwin 1944). A book in the Pelican series which will not only tell you all about it but how and why it arrived, is *An Introduction to Modern Architecture*, by J. M. Richards. With a little more technical detail, and more photographs, is *Building To-Day*, by Martin St. Briggs (Oxford University Press, 1944). Finally, here is a book covering the last four chapters: *The Arts of Mankind*, by H. Van Loon (who also wrote the *Home*, and the *Story of Mankind*). It is published by Harrap; and it abounds in the author's highly and individualized drawings and highly individualized opinions: a book to engender enthusiasm.

CHAPTER XVII

MAN THE CALCULATING ANIMAL

(Elementary Mathematics; Statistics)

THERE are two kinds of Mathematics, *Pure* and *Applied*. And the first is a sort of lovely dream world, "the only really pure thing left to us", the addict will tell you happily; but you have to have a very exceptional mind to be able to become an addict yourself. The second is used by the technician.

Why then, there comes the obvious question, should the ordinary person worry at all? "So long as I can count and give the right change!" one may say. But that would be a facile sort of reaction. For this is the truth: numbers and the manipulation of numbers have been throughout history a most important *tool* in the hands of mankind, and a tool, at that, not always for his emancipation but for his enslavement too (a statement which may seem to you more justified when you have reached the end of this chapter).

One thing must be made clear before we go any further. If you are "good at Maths" you may find this chapter chicken-feed, whereas if you are bad, even much that is here will seem almost too difficult. Either the *gene* of mathematical ability we inherit or we do not; there seems no half-way house. That lands us in a dilemma. We shall err, then, if anything, on the side of the elementary—while suggesting quite seriously to the expert that the simple outlook may give him ideas which he has not entertained before.

What, we believe, the ordinary person feels is the need for some *reassurance* about Mathematics. He realizes dimly that it is important

—and remembers vividly how bad he was, how he hated the subject perhaps at school. We also believe that that reassurance can to a large extent be given.

For remember this: that if Man is indeed "the calculating animal" (in contrast, that is say, to all other animals), he is none the less not an *easily* calculating animal. True it may be that discoveries in astronomy and geometry and the calculation of such things as the calender and the cycle of the year came pretty early in Man's history; yet firstly it was a very urgent necessity (of avoiding starvation) that produced the inventions, secondly it was only a very small minority who knew anything about it, and thirdly even that knowledge stagnated mostly for the best part of a couple of thousand years. It is not therefore a thing to be ashamed of to be profoundly bad at Maths. And as a second encouragement we come back rather particularly here to that leading idea of this book, that the grown-up has a much better chance of learning the subject without tears just because he is grown-up and his mind more mature. If you were made to learn your tables thoroughly at school you can thank your teacher, though you probably had no idea of doing so at the time. For the rest: perhaps all your Arithmetic and Geometry and the rest was at least a good training for the budding mind. (John Locke, the seventeenth century English philosopher, thought it was), although at that age it was pain and grief none the less. *Now*, you can cut out some of the hard grinding "examples", the *practice* as they call it, and have a look, rather, at the need, and the meaning, and the use, and perhaps even the fascination of it all.

Mathematics has been called both the "Language of Size" and the "Science of Numbers". No doubt both definitions are inadequate; but they are worth noting and thinking about. We shall start now with numbers, and finish the chapter with numbers, whatever we may meet in between.

Think, then, first of the number 10. Think about it hard, and particularly about the fact that we represent it on paper by a *one* and a *nought*. Note well the nought.

If animals cannot count, how did men begin? It is a pretty safe guess: on their fingers. *Five* doesn't get you very far, but both hands, *ten*, is useful. After that you start again. Ten, in fact, becomes the basic standard. Nine plus ten, nine*teen*; four times ten, for*ty*, and so on. That is all right.

But, when you get to writing, how are you going to put these figures down? Up to and including the Romans, people used either marks—the single stroke for one, two strokes for two—or else letters of the alphabet: in Roman numerals, V for 5, X for ten, L for 50, C for 100, D for 500, M for 1000. In an effort not to use too many letters you used IX for one-less-than-ten, and sometimes CD for one-hundred-less-than-five-hundred.

Now how, on paper, do you add :

M
D
CD
LXXX
XV
VI

The answer is, you just cannot do it—on paper. It is easy enough for us :

$$\begin{array}{r} 1000 \\ 500 \\ 400 \\ 80 \\ 15 \\ 6 \\ \hline 2001 \\ \hline \end{array}$$

If you had been a Roman, or for that matter a Greek or an Egyptian or a Babylonian, you would have used an abacus—which we know merely as a toy of wires and beads for the nursery. You physically totted up your beads on the "digit" wire and when you got to more than ten you *carried across* one bead to the "ten" wire and so on for the hundreds and thousands. It is amazing to think that that was actually how it was always done.

And then someone—someone from amongst the commercially-minded Hindus it is said—invented a way of doing exactly the same thing on paper. He invented the symbol for *nought*—"0"—to represent that "nothing" left on the digit wire of the abacus when you had carried across to the "tens". You can now add, substract, and do all the rest, on paper : and, what is more important still, *you need only nine different symbols to represent any number you like to think of.* For after you reach nine you merely shift to the left and start again : what is called *position* in figures has been invented.

Take a big jump from that—it is a jump in time as well as in idea, for as an invention it came nearly a thousand years later. After all, why stop there, why show only one side of the picture? If *one* with an ascending number of noughts after it represents 10 multiplied by itself an ascending number of times, *what about the descending scale?*

Let us, now, invent and use an innocent little dot, and say that if you put it before a *one* it means a tenth part of one, or one divided by ten. Then you can begin to use noughts in the descending scale, with ·01* meaning one hundredth and so on. We get, in fact, going as far up and down as we like:

$$\begin{array}{llll} \cdot 001 & \text{or} & \frac{1}{1000} & \text{or a thousandth} \\ \cdot 01 & \text{or} & \frac{1}{100} & \text{or a hundredth} \\ \cdot 1 & \text{or} & \frac{1}{10} & \text{or a tenth} \\ 1 & \text{or} & 1 & \text{or one} \\ 10 & \text{or} & \frac{10}{1} & \text{or ten} \\ 100 & \text{or} & \frac{100}{1} & \text{or a hundred} \\ 1000 & \text{or} & \frac{1000}{1} & \text{or a thousand} \end{array}$$

In other words, there is nothing after all so marvellous or at all difficult about "decimals". They are simply a great convenience. It is all a matter of thinking of everything in terms of ten multiplied by itself so many times or divided by itself so many times.

And then comes along another great convenience: *logarithms.* Those are easy enough too. For there is a more concise way of saying "ten multiplied by itself" so many times. Ten multiplied by ten we call "ten squared" or "ten to the *power* of two". The next is "ten cubed or to the power of three", the next "ten to the power of four", and so on. You know how we write this: 10^2, 10^3, 10^4, etc. But what about the descending scale? ·01 is a tenth of a tenth, or one divided by ten divided by ten. Can we not then write that as 10^{-2}? The answer is that we can, and do; though "to the power of minus two" is something easier to to understand in symbols than in words.

Now, notice this:

$$10^4 \times 10^2 = 10{,}000 \times 100 = 1{,}000{,}000 = 10^6$$

Those small figures are called *indices*; and you will notice that the indices on the left *add up* to the single index on the right. Then, further:

* Usually printed, incidentally, to avoid ambiguity: 0·01.

$$10^4 \times 10^{-2} = 10{,}000 \times \cdot 01 \text{ or } 10{,}000 \div 100 = 100 = 10^2$$

Again the indices on each side add up (or if you like to put it that way, subtract) to the same thing. *In fact*: when you multiply the different powers of a number you *add* the indices, and when you divide you *subtract* them. That holds good for any number, but it is easiest with ten because you merely have to play about with noughts.

But where do logarithms come in? Take it a bit further. If 10^1 (or "ten to the first power") is 10, and 10^2 is 100 and 10^3 is 1000, what about numbers in between? What is 43 or 62·5 in terms of the powers of ten? The answer is that they are (approximately) $10^{1.6335}$ and $10^{1.7959}$. (They have all been worked out for us, and are published under the title of Tables of Common Logarithms.) Now take those two indices, 1·6335 and 1·7959 and add them together: 3·4294. Then, by our previous finding:

$43 \times 62{\cdot}5 = 10^{1.6335} \times 10^{1.7959} = 10^{3.4294}$ (*adding* the indices.)

And $10^{3.4294}$ is (using another set of tables of an opposite nature, called anti-logarithms) 2687·5—which is the right answer. In other words, if only somebody works out, once and for all, tables that show *what index of ten* every number is, and again tables which show just the opposite, or what number every index of ten is, then you only have to use those tables, and whenever you want to multiply *you only have to add*, and whenever you want to divide *you only have to subtract*; which is exactly—that and nothing more—what logarithms do for us.

Indeed, one might say that this is quite a good guide for the adult appreciation of Arithmetic: that you should cease to worry about many of the complicated things you did at school (as an exercise for the mind), because such things as logarithms or slide rules or calculating machines (all depending fundamentally on what we might call the obligingness of ten) will do these things for you. Instead, you should concentrate on the business of being at ease with figures and appreciating what they can do.

One word of warning. Logarithms (logs for short), and even more so the slide rule, will only give *approximations*. But then, very often approximation is all that you need: we shall come back to that idea later.

Let us return for a moment to the significance of ten. Remember at least in one's everyday calculations such simple dodges as that to multiply by five one need only divide by two, and *vice versa*—at the same time, of course, shifting the "position" one place to the left or right, which means adding or taking away a nought or moving the decimal point. Then remember that to multiply by nine is merely to multiply by ten, add a nought, and subtract the number being multiplied. Finally, and more generally, remember that all the "continental" scales of measurement, which we spoke of in the chapter on Physics—length, volume, weight, cubic capacity and so forth—make use of the simplicity of ten, with prefixes that run:

LATIN	milli	=	$\frac{1}{1000}$th
	centi-	=	$\frac{1}{100}$th
	deci-	=	$\frac{1}{10}$th
GREEK	Deka-	=	10 times
	Hecto-	=	100 „
	Kilo-	=	1000 „
	Mega-	=	1,000,000 „

Yet after that we must, curiously enough, remind ourselves at once that ten nevertheless has its *dis*advantages. The continental system is *tied down* to thinking and writing in terms of decimals. And yet which is simpler or more natural to think of, "point one two five" or "an eighth"? Surely the latter, merely the half of a half of a half. In other words, *fractions* after all have their uses.

And then, of course, what about a third? Even so soon one comes across that rather queer and intriguing thing, the recurring decimal. For a third is ·33333 *ad infinitum*, or $\cdot\dot{3}$. (And so a ninth, of course, is $\cdot\dot{1}$) And all because three will not "go into" ten! Six would be a better number to stop at before you started again; but it is so small. The Sumerians did indeed have a system which was based, partly at least, on six. And then the Egyptians divided the circle (or "all round the clock") into 6 times 6 times 10 degrees. But that was probably because their guess at the number of days in a year (or the complete cycle of the sun) was 360. It is perhaps intriguing to think that probably if we had had five fingers as well as a thumb all would have been well. We should then (in English) have counted something like this: one, two, three, four, five, *click*, six seven, eight, nine, *plick*, ten—or, say: 1, 2, 3, 4, 5, δ, 6, 7, 8, 9, *E*, 10. You would have still had your decimal system and your logarithms and your convenience of playing about with noughts, and yet *three* fours (or the familiar dozen) would have been ten—and recurring decimals would hardly have existed.

Sane arithmetic is in fact a matter of using either decimals or fractions as the advantage lies—and of being at home with either.

Another example of being at home with numbers is to know without thinking what are the "prime" numbers—numbers, that is to say, which are indivisible or as we say have no factors: 3, 7, 13 and so on. Why some numbers should be prime and others not is rather naturally impossible to say; but if you had been alive when the world, and thought, were young, the idea would have intrigued you immensely, so much so that you would have invested those prime numbers—3 and 7 and 13 and so on—with magic properties of luck and ill-luck and "perfection" and the rest. . . .

Now take one of those simple "problems" which were perhaps the bane of one's life as a child but which, once we have learnt the trick, are likely to fascinate us so that we seek them out in the Press and the Puzzle Book.

"Three years ago a father's age was four times that of his son; in thirteen years' time the father will be twice as old as his son. How old was the father when his son was born, and how old is the son now?"

To solve that you let "x" be the son's age three years ago.

Then, by definition, 4x years was the father's age three years ago. Then:

$$
\begin{array}{lrl}
 & 4x + 13 + 3 & = 2(x + 13 + 3). \\
\text{or} & 4x + 16 & = 2x + 32 \\
\text{or} & 2x & = 16 \\
\text{or} & x & = 8.
\end{array}
$$

So the father's age was 4x or 32 when his son was 8; and, taking 8 years off both, he was 24 when his son was born. And, since x is the son's age three years ago, the boy must be 8 + 3, or 11 now.

Now there was a time when the school arithmetic book would not countenance the use of "x"—let him do it the difficult way and get more *practice*! And even now perhaps there is a feeling that to use "x" is either difficult or precocious or not quite fair.

It is, of course, mere common sense. It is using a new and a simpler *language*. It is putting down in a few straightforward symbols, which can be simplified still further, the statements which the "problem" has put so cumbrously in ordinary words.

We have in fact—as you had no doubt guessed—arrived at *Algebra*.

Algebra is, essentially, *generalized* arithmetic—the ability to generalize enabling you to go a great deal further than you could without it. It makes things so much simpler and neater. For instance you can, if you like, make the breathless statement: "The sum of all the consecutive numbers from one onwards can be found by taking the *number* of those numbers as far as you want to go, by multiplying that by the same number only one bigger, and then dividing by two." It is a great deal neater and more intelligible to say:

$$\text{The sum of the first n natural numbers} = \frac{n(n + 1)}{2}.$$

There you have a simple *formula*, that fits for any number you like to put in for the generalized "n for number".

Algebra in fact deals in formulae and equations. An equation is, as we have said, a statement: something *equals* something else—either invariably or in certain circumstances. If it is complicated you have to simplify it and "solve" it—rather as you have to translate an involved sentence into something more easily intelligible.

An equation can usefully be thought of as a pair of scales or a balance. Then, obviously, if you put twice as much weight in each scale, or if you put half as much, or if you add the same thing to both, they will still balance. And so, to turn back to our problem of father and son, we changed:

$$4x + 16 = 2x + 32$$

into

$$2x = 16$$

by taking away in turn first 2x and then 16 from each side.

Perhaps a more striking example of using very elementary algebra is in the old game of "think of a number!"

"Think of any number you like!" you say. "Double it! Add seventeen! Take away nine! Divide by two! Take away the number you first thought of!" And the simple soul will be amazed when you say, with certitude, "the answer is four." While he has laboured, you have merely said to yourself: "x; $2x$; $2x + 17$; $2x + 8$ or $x + 4$; 4." You have *generalized.* (You have been also careful to say, "take away the number you first thought of", or in technical language "eliminate the unknown".)

Now jump to something not quite so elementary: Quadratic-Equations.

A very simple problem about a projectile—firing a rocket or throwing a ball—will do. Obviously the thing has two forces working on it: the initial push and the force of gravity. If we had taken our Physics a little further than we did in Chapter II we should have learnt that the force of gravity produced an acceleration in a falling body of 32 ft. per second in each second, and that it would fall 16 ft. in the first second. Later we should have come to the "formula" for calculating the height which a projectile rises, working against gravity, where u is the initial vertical velocity and t the time in seconds since it started. It is:

$$ut - 16t^2.$$

Now, suppose that we are "given" that the initial vertical velocity is 128 ft. per second, and that we want to know after how many seconds the projectile will be at 240 ft. above the ground. Here *t* is the unknown (it needn't always be x !) and we have, by fitting the known facts to the formula:

$$240 = 128t - 16t^2,$$

or, taking 240 from each side,

$$-16t^2 + 128t - 240 = 0,$$

or, changing the sign—because if "minus something" equals nought so does "plus" the same thing,

$$16t^2 - 128t + 240 = 0,$$

or, dividing both sides by 16,

$$t^2 - 8t + 15 = 0,$$

or, finding its factors (for algebraic expressions may have factors just as do arithmetical),

$$(t - 5)(t - 3) = 0,$$

or,

$$t = 3 \text{ seconds } \textit{or } 5 \text{ seconds.}$$

That double answer may be a little surprising at first. But quadratic equations always have two answers—the reason may be clearer when we come to graphs. In this case the reason is fairly obvious, indeed it is what one would expect: the projectile in its curved flight has climbed to 240 ft. in three seconds, has reached its zenith, and in five seconds has come down to 240 ft. again.

Let us pass unobtrusively, on the back of "quadratics", to Geometry.

For a quadratic equation simply means that your "unknown" will come into the picture "squared"—you know the word *quad*rangle. Does that mean, then, that that little symbol ^{2} above a figure has any connection with an actual area which is a square? The answer is: obviously so, since to find the area of a square you multiply the length of its side by itself, or "square" it.

Look at this:

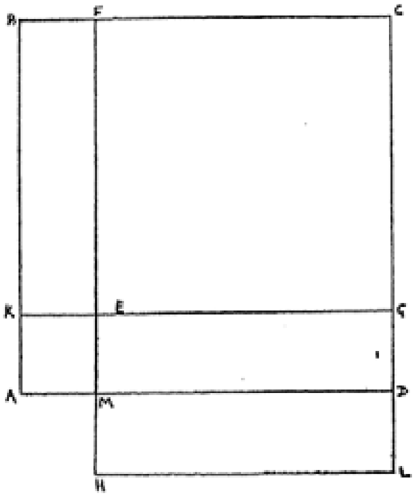
The result of $(a + b)(a - b)$ will be found by multiplying *each* term in each bracket by *each* term in the other. (And remember, if you multiply a plus thing by a minus thing you get a minus thing, that is to say the opposite of plus multiplied by plus.) Then:

$$(a + b)(a - b) = a^2 - ab + ab - b^2 = a^2 - b^2.$$

In words this is:

"the difference of two squares is equal to the product of sum and difference".

Now look at this diagram:



A B C D is a big square and A K E M is a little one: Their difference is the "bitten out" figure B C D M E K. And you only have to look closely for a while to see that the area of this figure is obviously the same as the rectangle H L C F—whose sides *are* respectively the sum and the difference of the lengths of the sides of the squares. Or in other words, once again: $a^2 - b^2 = (a + b)(a - b)$, where a and b are the sides of the big and little squares.

Now do this: draw two lines at right-angles, respectively three and four inches (or centimetres or anything else) long; join them and measure the third line. You will find it is five inches. This illustrates the fact:

$$3^2 + 4^2 = 9 + 16 = 25 = 5^2.$$

And that is the famous theorem propounded by Pythagoras (a Greek philosopher of the sixth century B.C., who combined Mathematics with Philosophy and Mysticism), to the effect that the square on the hypotenuse of a right-angled triangle equals the sum of the square on the other two sides. Though Pythagoras propounded it in its general form—and there is nothing mystical about this piece of knowledge—it was known long before in this its most simple particular manifestation; indeed to peg a piece of string knotted in these lengths of 3, 4 and 5 was the Egyptian builders' method of getting the very necessary right angle, and curiously enough is still used to this day.

Now that illustrates Geometry very well, because it can be looked at in just about those two opposite ways, either as algebra and arithmetic illustrated in picture, or as the very practical and necessary business of dealing with angles and areas and (in the more difficult but very important three-dimensional or Solid Geometry) volumes.

Geometry is the Greek for land- or world-measurement: it is the surveyor's, the navigator's, the embryonic astronomer's science—you will need it in anything from haggling over the size and price of a piece of land to charting the oceans or calculating the time, and men had not been living for so very many centuries before they were doing all those things. Telling the time without clocks for instance, how are you going to do that? The answer is, obviously, that the length of a shadow from the sun will be a guide, or more helpfully and accurately, the *angle* at which its rays strike.

And angles and the measurement of angles are so important that they have a separate branch of Mathematics to themselves. *Trigonometry*. They are important for this reason: that the measurement of an angle—by the theodolite or its earlier edition the astrolabe—can be much more easily and accurately effected than the measurement of a distance. You need a flat surface to measure a distance accurately—and where in Nature does one find it? When Great Britain was surveyed and mapped, one distance and one distance only was measured, the "base" on Salisbury Plain. The rest was an inverted pyramid of calculation by triangles, or trigonometry. As for measuring the Heavens—it hardly needs stressing that you cannot get there to measure by distance.

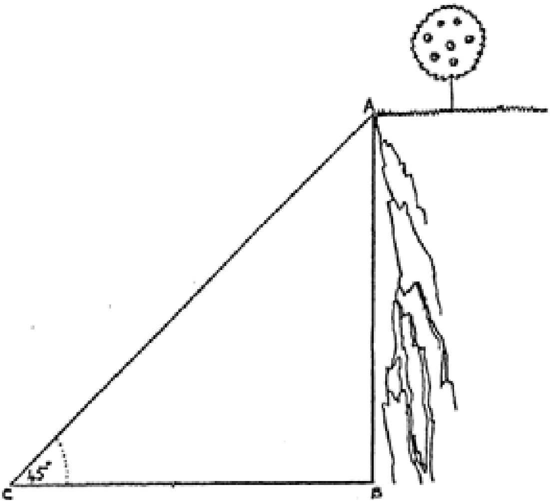
Even if you can get there, measurement without trigonometry is not always possible. How measure the height of a mountain or a cliff?

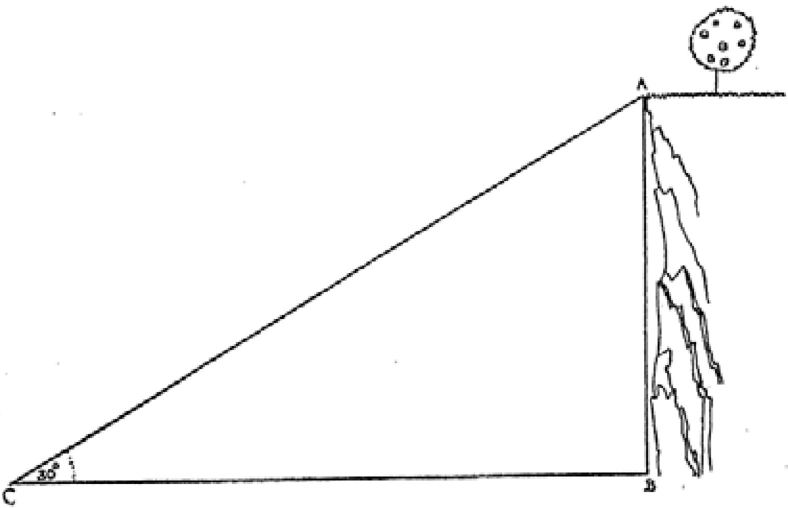
We can look into that a little: it will help us to appreciate Trigonometry. Now it did not take people very long to realize that once again the angle of the rays of the sun would help. In fact if you caught the sun at the right moment, that is to say when its rays were at 45° or half a right angle, your calculation was very simple indeed. For you had merely to take advantage of the fact that, in a right-angled triangle whose other two angles are 45°, the two shorter sides are equal. (See next page.)

And the ratio of $\frac{BC,}{AB}$ or $\frac{\text{shadow}}{\text{height of cliff}} = 1.$

But who wants to wait about until the sun gives an angle of 45°, or, for that matter, wait until the sun comes out? Instead, one invents that astrolabe we have already mentioned—an instrument for measuring the angle with the horizonal of anything you like to look at.

Say, then, that from a convenient point the angle of your cliff top is 30°.





You can still get your answer if in the triangle you know the ratio. AB to BC. In this case of 30°, since the triangle is obviously an equilateral triangle sliced in two, and remembering Pythagoras's theorem, you can see that it will be $\frac{1}{\sqrt{3}}$ or $\frac{1}{1{\cdot}732}$ approximately, or ·5771 of the shadow.

But your angle might be *anything*: $29\frac{1}{2}°$, 57° and so forth. What you want then is a convenient table of all these ratios for all angles, worked out for you just as logarithm tables are worked out. *That is what trigonometrical tables are.*

They in fact go further. For the other two ratios of the sides of a triangle are very useful too, $\frac{AB}{AC}$ and $\frac{BC}{AC}$; and these three ratios have been given respectively the names of tangent (tan for short—it is the same word as the tangent of a circle because in that way it was first worked out), sine (spelt sin for short) and cosine (cos for short).

There is of course the rather obvious objection that you cannot often reach the bottom of a cliff perpendicularly below the top, let alone that of a mountain or a building. But this merely lengthens the sum : all that is necessary is to take two angle-measurements at a known distance apart.

Next, *Graphs*. If we have a look at Graphs, we can reach, by way of them and with a very quick glance at what the Calculus can do, to that last branch of Mathematics which we are to tackle, *Statistics*—about which it is certainly our duty to have a few clear ideas.

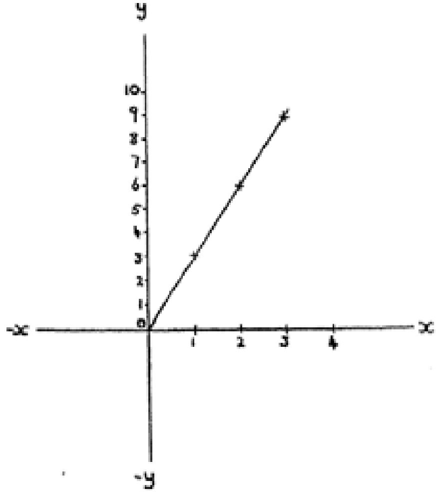
Graphs are diagrams of a particular sort. There are other sorts of diagrams to represent numbers, of course, and very useful ones at that : those ingenious affairs that you see in books and newspapers, where little figures, or shaded areas, of columns side by side, show you at a glance comparable figures which if merely written down would convey very little. But the "Cartesian" graph—named after the French philosopher Descartes who invented them—does more.

The idea is simple : have two lines at right angles—call them co-ordinates—and use them to measure, respectively, a variable and a function of that variable. Move to the right and upwards for *plus*, and the opposite ways for *minus*. You can then compare anything you want to compare : the distance travelled by a train compared with the time taken, the number of jobs done in an hour or a day, the number of babies born over a series of years, and so on and so on.

Take an extremely simple case as an example : a man walking at three miles an hour. The equation for this is $y = 3x$, where y is the distance walked (miles) and x the time (hours). The graph of y against x is shown at the top of the next page.

That graph is a straight line—a picture, we may say, of a man travelling at a uniform speed in space-time. If you wish, you can continue the straight line and "read off" from it how many miles he has covered in four, five, six hours and so on. (The fact that in this case it is easier to do it in your head is merely of course because we have taken so simple an example.)

For something a little less obvious go back to quadratic equations.



To plot the graph of $y = x^2$, you will give successive values to x and square it to get the corresponding value of y:

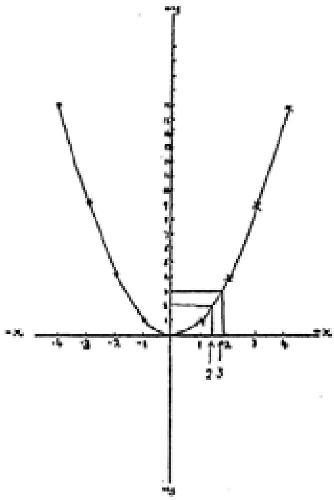
x	y
0	0
1	1
2	4
3	9
4	16

You can give minus values to x too—and remember that a minus quantity multiplied by another minus quantity gives a plus, for the rather obvious reason, amongst others, that it has got to be the opposite of a plus multiplied by a minus. We then get:

x	y
-1	1
-2	4
-3	9
-4	16

And the graph will look like that shown at the top of the next page.

From that you can *read off* the value of the square root of any number you like—for instance $\sqrt{2}$ which is 1·414 and $\sqrt{3}$ which is 1·732. Naturally you will not get your answer as accurately as that—indeed the degree of accuracy obviously depends on the care and skill with which you have plotted and drawn your graph. But there it is, that



is the sort of thing a graph does; and we shall meet the idea again very shortly in Statistics.

That graph of $y = x^2$ is incidentally a curve called a parabola, as will be the graph of any other quadratic equation. It will vary in flatness and steepness of course, just as will a stone thrown or a rocket fired. And that stone or rocket—except for the influence of air resistance—itself follows the course of a parabola—which is perhaps what you would expect. . . .

But come back for a moment to graphs of men walking, or trains or motor-cars going at speed, and to all the sums set about them. They all make one assumption: that the thing is going at *constant* speed.

Surely that is an unwarrantable assumption? It is, very much so; what is happening in actuality is a continual change of speed, accelerations and decelerations. That is what is important, what mathematicians need to know about: the *rate of change*. It was so important that that very great mathematician, astronomer and physicist, Sir Isaac Newton, invented a whole new method to deal with it: he called it The Differential Calculus.

Now *that* we are not going into, any more than we are going into the opposite process, the Integral Calculus, which helps amongst other things to find volumes of spheres and other even more difficult objects. There is no half-way house about this—either you study the subject or you leave it alone. In actual practice the Differential Calculus can be used to measure the *steepness* of the curve of a graph—and perhaps you can see dimly that that is the same thing as measuring rate of change. A very simple calculation would have given you the fact that that projectile, which was at 240 feet of height after both three and five seconds, reached its zenith, that is to say changed from going up to going down, after four seconds—a fact which would not have been so obvious in an example less carefully arranged beforehand for simplicity! And not only the astronomer will use the calculus but also the engineer in such things as the rate or "co-efficient" of expansion of materials subjected to heat.

And now finally for *Statistics*, and certain other conceptions that group themselves fairly closely round that somewhat suspect subject.

It is an irritatingly common quip: "Statistics can prove anything." The correct reply is that they will do nothing of the sort *so long as they are compiled honestly and read with intelligence.*

We come in fact right up against the idea propounded at the beginning of this chapter, that mathematics are a power that *can* be used to enslave as well as to emancipate mankind. An example of enslavement in the past was that deadening age-long conservatism of the early Egyptian and Mesopotamiam empires and city-states that we met in our chapter on History, where a hierarchy imbued their simple knowledge of floods and seasons and calendars with secrecy and magic to help them keep an ignorant and superstitious peasantry tied to the land and to a primitive routine.

In the modern equivalent "enslavement" is perhaps too strong a word. But there is a real danger of men allowing themselves to have ideas and orders and enactments that are no good to anyone foisted on to them, purely through muddled thinking. The unscrupulous politician may frighten us into panic action by telling us that the colossal sum of £10,000,000 has been wasted or lost on this or that. The health crank may persuade himself and you that this, that, or the other ought to be done to everybody because the "average" number of cures was a hundred per cent. Even the true but over-excitable statistician may exceed his functions by unwarranted prophecies of, for instance, population-change.

Take these three in turn. The questions to ask yourself when someone seeks to impress you with big numbers (of money or otherwise) should be: "*Is* it really impressive? What is its significance, what does it compare with?" In this instance, if one were told that one had oneself lost £10,000,000 or even that, say, one's village community had, it would spell disaster. But if it is spread over the whole country's population, and represents somewhere roughly about one per cent of its yearly income, then its significance is very considerably reduced. There is a great advantage in having a proper consciousness of the *order of* *magnitude* of things, and so of their relative importance—a thing not taught much in schools.

The second of our three examples of wrong-headedness brings us to the question of *averages.* First remember that there is more than one sort of average. Most people only know of one sort, the arithmetical average—that is to say, adding up the lot and dividing by the number of them: the average of 5, 10, 15, 20 is $\frac{5 + 10 + 15 + 20}{4}$ or $12\frac{1}{2}$. But there are instances in real life where such an average is not only of no significance but misleading. Imagine yourself firing at a target with a bull's-eye and a great number of concentric rings where you score 50 for each bull's-eye and one less for each ring out from the centre. Imagine further that nearly all your shots are very good but that by some aberration a few are a great number of rings from the centre, scoring 5 or 6 or so instead of the usual 48, 49, 50. On an arithmetical basis those few very bad shots would lower your average a great deal. But the real significance of your shooting is the big mass of holes in the middle of the target and nowhere else. Now there is an average of that sort, it is called the *mean,* and is just simply where the mass of examples are.

But the health crank who talked unwarrantedly about a 100 per cent average cure would have been misleading in another way. The question is: in his 100 per cent cure *how many cases were concerned*? Bernard Shaw quotes somewhere the case of a local authority which boasted just such a 100 per cent success of vaccination. And the number of cases was somewhere about *three*! For all the Authority knew, cases 4, 5 and 6 might have all been *un*successful. In other words, averages have no significance until the number of instances is large, *and the larger the number, the more reliance can be put upon the average.*

A way of getting round the need to cover a very large number of instances before your answer can have any significance is to take what are called *samples.* This "statistical sampling" is used in the public opinion polls lately so popular—where enterprising canvassers ask people what is their favourite film star or how they intend to vote at the next election, and deduce therefrom the opinion of the masses. The idea is that a *mass* of people need not be questioned, but rather a *selected* bunch—a few in each age group, in each income group, each profession, and so forth. Of course, the selection of the samples must be made without bias and with great skill and care; and if any instance in the deductions from this sampling are demonstrably false—as they were outstandingly in the American 1948 Presidential election—that is not to discredit the theory of statistical sampling but rather to say that either the sampling was done badly or that *prediction* from such samples are seldom justified since people are always entitled to change their mind.

The largeness of the number of examples taken enters very much into the theory of *chance*. The fact that a penny has come down heads three times running is no real reason why it should come down tails next time. On the other hand, there is obviously for *any* toss an equal chance of either heads or tails; and if you toss a hundred times you will find it will approximate somewhere near to 50-50, whilst if you like to spend your evenings doing it a million times it is a safe bet that it will work out at very nearly 50-50 indeed. There is incidentally a whole science of Chance, dealing with what are known as Permutations and Combinations, or the way things can be sorted or can happen. The Football Pools expert will know quite a lot about that—though if he were highly reasonable and did not merely enjoy a gamble the thing he would really learn is what a slender chance of winning any gambler has. Another thing which depends upon the law of averages is the whole business of life insurance: if you spread your risk over a large enough number of cases, and at the same time have a decently large capital behind you and have worked out your risks correctly, you cannot—short of a holocaust—lose.

And now the third instance, of the statistician predicting population trends into the future. This is not to say that he will err, but that he may.

You remember that graph of $y = x^2$ and the idea of using it to find square roots, that is to say to find other points on the curve than those you used in plotting it? That is called *interpolation*. But you can also *extra*polate, or go outside the curve you have plotted. In other words, if you plot a curve of population, numbers of people born each year, and find that it sweeps downwards, then you can continue that curve in the way it seems obviously to be going, and say: in 1969 the number of births will be so-and-so. To be fair to the statistician, he will add "other things being equal". And that is the real point, that one must in such things take a good deal of notice of "other things being equal". For they may very well not be equal: in the future any sort of quite unpredictable change in the social environment may arrive. In fact: "extrapolation should be looked on with suspicion".

Indeed quite apart from "extrapolation" or continuing-the-curve, that phrase "other things being equal" should always be remembered: Sometimes it is left out altogether when it should not be, sometimes its weight is so great as to invalidate the figures altogether—because things probably won't be equal. It is no good saying—as somebody might—"when Napoleon threatened invasion 50 per cent of the people vowed they would surrender; therefore if Hitler had come he would have won!" For, whether or not the first statement is true it has little or no *bearing* on the second, when people and times were different, and where in any case you are dealing with imponderables, in which figures have no place or significance at all.

That brings us to the last, and the most general, warning about statistics. Statistics *compare* things: the number of people who do this with the number of people who do that, and so on. It is the statistician's job to see that the things he compares really are significantly comparable—and it is the job of the public to see that if he fails he is properly ignored or discredited. An exaggerated example will show what is meant. "The number of car owners that suffer from athlete's foot is 87 per cent." The sufferer who, on reading that, sold his motor-car would be a fool. . . .

And even if we are not as foolish as that, there are at least occasions when we are not far from it. As we said at the beginning, Mathematics is a difficult subject, and Man is not *naturally* a calculating animal. All that the average man can do is to be wary with, but not afraid of, figures—and secondly to realize, a little, how much the modern word and the modern expert—engineer, accountant, astronomer, musician, surveyor, builder, architect, electrician, pilot—depends upon the art and the science of it all. It is rather like mountaineering: the amateur can have safe fun on the lower slopes; he can also look up and survey, with interest but without envy, the experts on the breathless heights above.

BOOKS: Probably the most helpful book for a beginner, though it is written primarily for the parent and teacher, is *Easy Mathematics*, by Sir Oliver Lodge, published by MacMillan & Co. in 1905. Two other books, one also rather old and one new, are *An Introduction to Mathematics*, by the philosopher D. N. Whitehead, published in the Home University Library Series; and *Mathematics for the General Reader*, by E. C. Titchmarsh, published recently in Hutchinson's University Library Series.

A big book published in the 'thirties which caused something of a stir because it was so refreshingly different from the average text-book was *Mathematics for the Million*, by J. L. Hogben (Allen & Unwin). That tells you in a most fascinating way just how and why man gradually acquired his counting and calculating skill. But it is perhaps fair to issue a warning that it goes deeply into the subject and that much of it is for the enthusiast rather than the amateur. Nevertheless its early chapters are the best tonic possible for those who are afraid of Maths.

SIGNS: Finally it may help to explain a few of the more usual signs that are met with in Mathematics—the most usual, of course, we all know.

$<$ Is less than.
$>$ Is more than.
$\geqslant$ Is not less than.
$\leqslant$ Is not more than.
$\simeq$ Approximates to. (Another way to express approximation is to put "c" before a figure, meaning "circa", Latin for "about".)
∞ Infinity. (Infinity is really neither harder nor easier to appreciate than Nought. It is, if you like to put it that way, $\frac{1}{0}$. It might be defined as a number larger than can be imagined.)
! "Factorial." For instance 4! means "factorial 4", or 4 multiplied by all the numbers less than it: $4 \times 3 \times 2 \times 1$.
$\propto$ Proportional to.

There are plenty more—$\int$ (the old-fashioned s) for the operation of "integrating" in Calculus for instance, or the Greek capital letter Sigma, Σ, denoting *summation*—but there is little benefit in knowing names without significance. Most of the Greek letters incidentally—π is of course the most familiar—have been marshalled into use by the mathematician and the engineer to denote something particular, some constant or coefficient or the like.

CHAPTER XVIII

THE WEALTH AND WELFARE OF MAN

(Economics: Money)

WHAT is Economics? What is it all about? Why even should there be such a subject as Economics at all?

Anyone who dares to ask such questions is not being foolish, indeed he is being remarkably intelligent. For he must have somewhere at the back of his mind an inkling of the truth—which is this: that it is really only the (comparatively speaking) modern way of life—the *complication* of life—that brings Economics into being.

By complication—call it complexity if you prefer—we mean that thing which arrives directly you begin to get the surplus and the division and specialization of labour which we described in our first History chapter as the prerequisite for the growth of civilization. In other words, produce simply and primitively for yourself and your family alone, and economics hardly arises; produce for the other man, produce "for the market", and economics has come into the picture at once and to stay. And the more intertwined and interdependent and industrialized and complicated our civilization becomes, so economics grow in importance. For remember that our industrial civilization has indeed become tremendously complicated; *that*, one may say, is its essence. And when a machine has become complicated it will not necessarily run smoothly or without breakdown.

Economics has always had brickbats thrown at it, has always been maligned. It has been called the Gloomy Science, has been dubbed "inhuman". Sometimes perhaps its own practitioners have asked for such criticism by being doctrinaire and narrow-minded. Largely however it has been a matter of misunderstanding on the part of the accusers of what the science sets out to do or claims to do.

John Stuart Mill, that knowledgeable nineteenth-century philosopher, once laid himself open to this accusation of being narrow and utilitarian and inhuman. In his *Principles of Political Economy* he innocently defined the possession of wealth as "to have a large stock of useful articles". He at once had uprising in his wrath against him, like a bearded and minor prophet and full of the most magnificent invective, John Ruskin.

Ruskin recited the story of the gentleman who when shipwrecked tied two hundred golden sovereigns round his middle—and of course took them down with him to the bottom of the sea. One must, in fact, add to the definition of wealth the further words "that one can use". Indeed, added Ruskin, one must go a good deal further and say "use and not *ab*use". What really mattered was that wealth should be in the hands of those who could *use it well*. The captain of industry should be as noble a figure as the captain of soldiers. True wealth was "the possession of Value by the Valiant".

Now all that was indeed magnificent. Up to a point perhaps it was even warranted. For the Science of Economics or Political Economy, starting more or less with Adam Smith's *Wealth of Nations* in 1776, a book directed against those who sought to smother the budding industrial revolution by too much restriction, had at that time developed into a pretty heartless exposition of *laissez-faire* and the devil take the hindermost. But, by and large, though undoubtedly Ruskin was justified in girding at the materialism and Philistinism and pessimistic cruelty of his age, he was not justified in condemning Economics.

For Economics does not set itself up to be Ethics. To take a more modern example than that of Ruskin's dispute, Economics will not assess the rightness or wrongness of a redistribution of income by means of "soaking the rich", it will not express an opinion on the morality of a "price economy" as opposed to a socialized regime; but it will on the other hand seek to tell you just what is likely to happen if you do pile on your taxes, and will describe for you in detail the theory of value that lies behind a system of totally unrestricted buying and selling in the market.

Further than that, Economics recognizes itself as an *inexact* science; and it does so for this reason, that the machine it seeks to analyse and describe, the industrial machine, is a *human* machine run by human agency. And only a very little knowledge of psychology and anthropology will convince anybody that men in their actions are not always predictable or reasonable and that even if they do know which side their bread is buttered they are on occasion as likely as not to turn the bread butter side down.

The real trouble is that most people are horribly vague as to what Economics is trying to do. And that at least is a vagueness of which we should do our best to rid ourselves.

First of all we must be clear what we mean by an "economy"—a World Economy, a National Economy and so forth. It is fairly obvious: we mean the whole set-up of buying and selling and making, the vast complicated picture of selling our skill and labour to produce goods and services for one another and of receiving an income so that we can buy our share.

Economics seeks to describe that picture, to propound theories based on close examination of that picture, and to present practical proposals for the future and for the betterment of the existing scene. Its proposals *may* not be right proposals because of that unpredictableness of human nature; its proposals may well have to be considered alongside proposals dictated by ethical considerations and may well have to bow before them. Nevertheless neither proviso vitiates entirely —indeed by a long way—the value of Economics.

To repeat, then, these we may say are the three divisions of Economics: *Drawing the Picture, Propounding the Theories, Solving the Problems*. We shall take a look at each of these—reserving the first of them however, because we want to combine other things with it, for the next chapter. In the process we shall consider in a little greater detail that thing which it is essential to have some clear ideas about: *Money*.

First, Economic Theory. It is a generalization not too wide of the mark to say that all of this centres round one idea: the Theory of Value.

One thing must be made very clear here. When the economist talks of Values he is not talking of absolute values. In absolute values one word of the gospel of Christ may be worth a millionaire's ransom. That is where Ruskin misunderstood, or perhaps where economists showed him an all too wide chink in their armour. The economist must never forget that ethics always need to be considered—but not by him.

What the economist means by value is value in terms of money or "value in exchange": what you and I think a thing to be worth to us in pounds, shillings and pence, whether that thing be a seat in the cinema, the house we think of buying, or the price at which we are willing to sell our own services.

Price is indeed the word, price "in the open market" (using the word market very widely and often metaphorically). Everything material, says the economist, has a price; and price is the governing factor and is itself governed by factors that are often subtle and difficult to assess. But here is another thing to be made very clear. Our books on Economics, in their often long analysis of the theories of value or price, are making one big assumption: that it is indeed all in the open market, and that the set-up is, in that phrase used at the beginning of the chapter, within a price-economy. We mean by this that our choice—of what we buy and sell and do and make—is unrestricted and governed by a more or less cold assessment of what it is worth to us in money. It is, in other words, the capitalist set-up that is envisaged and not the socialized state.

In a price-economy, do not forget, everything depends upon the interplay of Demand and Supply: not only the price at which you buy but *what* you buy, that is to say what is produced. It is only the expectation of being able to sell at a profit that induces the manufacturer (or his financial backer) to embark on production.

Into all the intricacies of the theory of value—elastic and inelastic demand, marginal utility and the rest—we cannot go. One point is worth thinking about however. The "Means of Production" are sometimes categorized as on the one hand Labour (the job being done) and on the other Capital (the plant and so forth that enable the job to be done). But a further and useful differentiation is to divide off *Land* from Capital and to treat it separately because it suffers particularly from a peculiar disability, which is the iron law of "Diminishing Returns". This is only to say that, whereas if you use your plant and factory for double shifts of labour you are likely by various economies of overhead expenses etcetera to more than double your output, yet you cannot do the same thing by sowing twice as much wheat in a wheatfield. You are up against the hard limitings of Nature, which rules that, after a certain point, for everything more that you expend on your land you will get not a parallel monetary reward but a diminishing one. That talk of Land and of Nature may seem surprising; but it serves as a very useful reminder of fundamental realities—a point which we shall be making and stressing at the very end of this chapter.

Turn now from Theory to our last division, Economic Problems.

Two economic problems of immense importance to us nowadays, and which to a considerable degree are interrelated, are, first, Boom and Slump and the inflation and deflation of money that go with them, and secondly Unemployment and Full Employment. Those, somewhat shortly, we will consider. But before we do so we must get into our heads some clear conception of money and out of them some popular misconceptions on the same subject. A few words then about *Money*.

Money has certain criteria. If it does not fulfil them it is not good money—whether it be the cattle or cowrie shells of the Primitive or the cheque and banknotes of the Modern.

(1) Money must be a *Standard* of Value or Exchange. Which is simply to say that you must be able to measure anything—anything that can be reasonably expected to have a price, that is—in terms of it. It must be a "common measure" of exchange. The alternative is the maddening inconvenience and idiotic slowness and uncertainty of barter.

(2) Money must be a *Medium* of Exchange. You do not only want to measure by it but to use it—use it always and conveniently. (You remember the idea in our first History chapter, that the introduction of coins and small change democratized money or brought its use down to the common man.)

(3) Money must be a *Store* of Value. In plain words it must *keep* and not go bad. Cattle don't keep indefinitely, nor do cigarettes. But, in case we feel complacent, the best of moneys can "go bad"—by inflation, by losing a large and increasing part of its store of value until it becomes even entirely unacceptable.

Can paper money fulfil these criteria as coins do? The answer is that of course it can, even better and more conveniently. But also of course there is more risk and possibility of its going wrong. It needs confidence and integrity—confidence on the part of those who use it and integrity upon the part of those who create and control it. Paper money is a *civilized* type of money; it needs living up to. . . .

We arrive at Banks and banking. For banks are the originators and issuers (whether centrally controlled or not) of paper money.

What, fundamentally, do banks do? For thousands of ordinary little people they do no more than look after their money—their wages and salaries and so forth as they pay them in—and afford them the convenience of paying for things by cheque instead of cash. There is nothing startling or significant about *that*; that does not create money. But the more important function of a bank is to *lend* money, to afford a loan or an overdraft to big men and little men who need it. Where does the bank get the money from? Obviously from what those others who don't want a loan have put in. Further than that: the bank can lend out considerably *more* than it takes in. That idea of big numbers and averages comes in again: so long as there is confidence in a bank—as we run things in this country now there always is—it is a safe bet that at no time will everybody be wanting all their money.

There is, of course, nothing immoral on the bank's part in doing this.

It performs a great service to the public; the interest it charges is its reward for that service, covering its profit and its expenses and enabling it incidentally to perform a number of other minor services free.

Nor is there anything either sinister or magic about this creating of money by the bank. Let us get this perfectly clear. In so far as the bank creates loans above its total deposits, and in so far as the borrowers use those loans by putting cheques into circulation, money and, as we say, purchasing power *are* created. But the bank's only benefit is the interest it gets—it is not in some marvellous way enriching itself by creating money. And further, the amount of extra money that it can put into circulation is severely and practically limited by the fact that it must quite definitely not exceed a certain proportion of its cash reserve.

It is the same principle with banknotes. Once, very many banks could issue their own notes—simply pieces of paper promising to pay hard cash on presentation. Now in this country it is only the Bank of England (*i.e.* the Banker's Bank) which does this. The Bank of England issues our £1 and 10*s*. "Treasury Notes" and the banknotes for £5 and upwards (which the little men seldom see); and because we have faith in them we accept them as readily as if they were coin intrinsically worth the sum which is merely printed on them. And *finally and fundamentally Parliament controls the issue of these notes.*

Once more let us be perfectly clear. The community is not in any way a real gainer by the issue of more notes and cheques. Again you cannot get something for nothing. It is the work done and the things made that really count and make a community wealthy. Of course, it is true that an unscrupulous and an uncontrolled government can help *itself* at least temporarily by issuing a rush of notes; it can use them instead of going to the trouble of collecting taxes. But that is only to say again that paper money is a civilized method which has to be lived up to by civilized men and governments.

For no good government issues more paper money than the country's economy seems to need. Why? Quite obviously because it does harm, because it waters down the money in circulation and makes everybody else's money less valuable. If in a country a hundred million pounds is in use to buy all the goods and services for sale at any moment, and if at the next moment an unscrupulous government suddenly issues another hundred million pounds' worth of notes, then everything will cost twice as much. Your criteria of money that it should be a safe and steady *store* of value has gone.

That is inflation. But remember this: it is the money *in circulation* that counts, what is called effective demand; money lying idle obviously has no effect on the rest of the money that is being circulated or on its relative value.

No one of course will pretend that there is not a very great deal more that can be said and learnt about money. But if one is in possession of a clear head and a few sound first principles one need not feel at a disadvantage with anyone who may talk learnedly about Gold Standards and Bimetallism and Social Credit and the rest: it is just possible that the glib talker is a little hazy on first principles himself.

And the first of all principles is that money is a means and not an end, is an instrument of wealth and not wealth itself. That sounds too obvious for words—Ruskin's shipwrecked gold-carrier must indeed have been a fool! But just because money is so much a part of our modern lives, always to remember or appreciate this truth is by no means easy. He forgets it who is always saying about this or that social scheme, "Where is the money coming from?" For the answer is, quite baldly: *it can be created.* If after it is created men do *not* work and produce, if for instance employment is worse and not better, then indeed harm is done: money all round will be worth less, inflation will have been caused. But work hard, produce more, set the wheels of industry going faster or more steadily, and all will be well; there is no difficulty, the extra money created will merely keep the balance between goods and purchasing power. Money is a willing servant to an honest and understanding master.

A fallacy as prevalent as "where will the money come from?" is the resentful and regretful "well, it *gave employment* anyhow!" in apology and excuse for the retention of any wasteful practice. To have to *make*, or indeed retain, employment which is in essence unproductive, wasteful, perhaps degrading to the employed, is obviously a mark of an imperfect economic system. It must be remembered that we in this country suffer from two memories; one is of the early decades of this century when ca'canny methods seemed the only way to keep oneself in a job, and the other is of the Victorian Age when as a nation we were so rich and could extract such tribute from the rest of the world that we could afford to employ a quite fantastically large army of servants, valets, flunkeys and hangers-on. "Making a job" is a pretty poor admission of failure to build a sane economic system of full employment.

But is such a system easy to build? (We come now to the two particular problems we promised to consider.) Rather obviously it is not. It seems almost as if it is only in wartime that we can do it, which is again a pretty poor commentary on our intelligence. But the lesson there is not so much that we can, apparently, only get everybody employed if we proceed to destroy forthwith (or store up for possible destruction) half that they make, as rather that we can only get everybody employed if we are willing to impose controls and regimentation.

There lies the significance of the title of Lord Beveridge's great enquiry and great book, *Full Employment in a "Free" Society*. It is in fact a matter of compromise. It is not too hard to give everyone a job if you impose absolute control, if you say just what shall be made and order people to go and make it, and see that you are obeyed even if it means people uprooting themselves and living in misery to do it. You will of course have to control finance too; for you will be deciding when and what capital goods—factories, plant, buildings—are to be made and just what abstinence there shall be in order to provide it. There will be, in fact, hardly an end to control. And the question obviously arises, is it worth it? On the other hand, the crude alternative, mass unemployment, is too grim to be contemplated.

Yet most people believe that there can be a reasonable compromise solution. It is in essence this: that there must be some control—a direction of production, of the labour force, and of investment—and that if people will face up to that much and respond willingly to it, then unemployment as a major social evil can be cured. . . .

The great thing to be guarded against is of course the Slump and Boom, that curse of a capitalist society. Why does that happen? It is fairly obvious. If you only produce because you think you see a profit, and produce more if you think you see more profit, then once a purely static position is left behind any tendency will be a *growing* tendency. Optimism breeds optimism. And, more materially, rising employment and demand creates more money—those cheques which the optimistically overdrawing business man can use—and more money creates yet more demand. *Until*, to put it vulgarly, somebody gets the jitters.

Lord Keynes—J. Maynard Keynes on his book titles—had led the way in analysing the slump-and-boom, or trade cycle, and in suggesting remedies. The general idea is to restrict or make difficult and costly the issue of more money and credit when the business world is staging a boom, and to create an "effective demand" by State activities—the building of capital assets and so forth—when a slump might otherwise arise. Another aspect of the same idea is "enforced saving" (for example our Income Tax Post War Credits) when there is too much money chasing too few goods, and then the return of those savings when the opposite position arrives. Another method, when there are too few goods being chased by too much money, is to prevent or minimize the normal working of supply and demand by rationing or price-controlling the too-few goods. Those who grumble will not have suffered the quite appalling evil of a real, thorough, honest-to-goodness inflation.

The most complicated aspect of money is the international aspect. At least one word of warning here: there is little use in reading, as one may in most books on the subject that are not very modern, long dissertations on the international financial system as it existed before World War One, for it is a system which is dead. Now most nations—most but not all—control their currencies, and the picture is confused and not straightforward. One simple idea, however, we can absorb.

It is the brutal and simple fact that if you want to buy anything from another country you have got to get hold of some of that country's money to buy it with. There is no avoiding that—unless you can borrow or cadge a gift! And, short of borrowing, you can *only* obtain the other country's money by selling things to them. If the other country doesn't want your goods—then, unless you can do a deal through an intermediary country, you must go without; or make something it does want.

That of course is the position that has arisen after the Second World War, between the United States of America on the one hand and almost the rest of the world on the other. The rest of the world wants dollars with which to buy American goods, and the U.S.A. has no great need to buy the rest of the world's goods with her dollars.

And now the final point to bring us back to fundamentals. We have talked a great deal about complexity and complication. We have cited these as being, in the world of work, the real cause of the existence of the science of Economics at all. That is largely true; and if we ever reach a simpler, stabler world, Economics will lose much of its importance and will be less on everyone's tongue. But do not forget the *opposite* point.

It is this: that however complex our economy may be it still has a simple foundation. And this foundation is the land on which we live and the sun which gives life to that land. Whenever you become too involved in the detail and complexities of economics, remember Akhnaton's hymn to the sun!

Economics in fact is a branch of Ecology—which in its turn is a branch of Biology. We are all denizens of this earth, part of its swaying and struggling cycle of life.

We are, then, better and wiser students of economics if, when we discuss wage-rates and five-day weeks, and quotas and tariffs, and hard and soft currencies, we remind ourselves occasionally that the sort of human fecklessness that can create a dust bowl or an unsupportable increase in world population could still in this twentieth century pull us all down to a barbarity where wage-rates were never heard of and five-day weeks never dreamt of. Only *bad* economics is divorced from reality.*

* The economist who first warned people of the significance of their continual pressure on the means of subsistence was Malthus, who 150 years ago pointed out that human population, if not checked, increased in geometrical progression whereas the production of food increased only in arithmetic.

Here as a tailpiece, as we had in the Music chapter, are a few technical terms which, because they are so prevalent, deserve a few words of definition:

Marginal. This is a favourite and a very fruitful idea amongst economists. For instance the person who combines muddle-headedness with dishonesty may well say to himself in travelling without a ticket on the railway, "well anyway *I* didn't cost 'em any more!" But obviously if you increase the number of passengers there comes a time when a whole new train has to be run; and the passenger who causes that extra train might be called the *marginal* passenger. A more orthodox use of the term is to talk about marginal land, meaning land that is only just worth cultivating and is in fact on the margin of not being worth cultivating at all. That land, in theory, will command *no* rent for the landlord—unless of course he puts in some of the new plastic soil conditioner, krilium, in which case it will no longer be marginal land! Marginal Utility is perhaps best illustrated by the hungry man. Give him, say, a Cornish Pasty and he will be very grateful; give him three and he will eat them; give him a fourth and he may well say, in the classic phrase, that he would rather have a bottle of Worthington. The third is the pasty of marginal utility.

Real and Money Capital. (Or sometimes called Capital Goods and, quite simply, Capital.) Here lies a distinction of paramount importance. Real capital, as we have said, is the plant and so forth that enables a job to be done; it is the opposite of consumable goods, it is the buildings and machinery and tools that have to be made before the things you really want can be made; it is that "surplus" which we spoke of as the first prerequisite of the growth of civilization—real capital began, shall we say, with the paleolithic hand-axe. Money capital is the money that has to be saved and spent in order to produce the real capital: one abstains from demanding consumable goods whilst one pays for the tools. It is the control and co-ordination of these two abstentions, of demand and of supply, that constitutes one of the main practical problems of Economics.

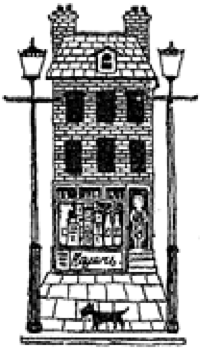
The Sterling Area or Bloc. Sterling is of course the name for British money—it is pleasant to think that it has such a worthy name—and the countries that either use that money or tie themselves to it, to a greater or less degree in the workings of International exchange of currencies, call themselves the Sterling Area or Bloc. It is basically the British Commonwealth of Nations, with certain exceptions that from propinquity find it more convenient to tie themselves elsewhere (e.g. Canada to dollars).

Hard and Soft Currencies. This, rather surprisingly, is almost colloquially what one would expect it to mean. If a foreign currency is in short supply and so difficult or hard for a country to obtain, then it is, for that country, hard. If it is easy—a soft job—then it is soft. American dollars are a hard currency for us, and vice versa.

BOOKS: For Economics generally try one of these: *The Social Framework*, by J. R. Hicks (Oxford University Press), or *Everyone's Economics*, by Robert Jones (Sidgwick & Jackson), or a Handbook published by the Bureau of Current Affairs (for which see end of Chapter XX), *Explaining Economics*, by Gertrude Williams. Before you have read something of this sort, however, do *not* try a serious student's book on economic theory.

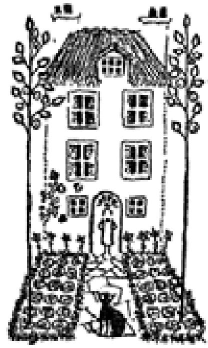
On money, there is *Your Money and Mine*, by Barnard Ellinger ("Charter for Youth" Series, Thomas Nelson & Sons.)

Often small popular pamphlets appear, official or otherwise; do not think them beneath you. Lord Beveridge wrote one on his own big book on unemployment.



CHAPTER XIX

THE WORK OF MAN



(Descriptive Economics; Production; Commerce)

TWO facts: Man is the child of Nature; and Modern Man is quite startlingly divorced from Nature.

The first of these has been stressed at the end of the preceding chapter. Nevertheless let it be said once more. However much we urbanize ourselves and live in an artificial, man-made environment of streets and cinemas and shops and the like, yet let there be lack of fertility through drought or storm or flood, whether in the course of nature or through man's own interference and stupidity, then man will suffer as surely, if not always as quickly, as he did when he wandered over the face of the earth with an eolith in his hand and a look of innocent wonder on his countenance because he had never heard of a shop or a street or a pavement, or a Trade Union or the Nationalization of Industry or a Forty-Hour Week.

Now in this chapter let us take the other fact, lest in stressing one we lose our balance and, because we have not sufficiently noticed it, trip over the second. We do live nowadays very much in a world of town and shop and factory; we are urbanized, mechanized, industrialized; we live in a complex, interdependent world where such things as wage rates and trade balances and all sorts of economic world organizations, which men call all too familiarly and confusingly by titles taken from the first letters of their names, impinge upon our consciousness every day in the newspapers. Man is a commercial and industrial animal, and we have got to take notice of the fact.

This chapter however—on "Descriptive Economics" plus a little more—will not be a long one. All too easily here could we become bogged down in detail. What we need, rather, is to acquire an *outlook*.

First, because this is a picture we are looking at, the Economic picture, we may take the opportunity to think again of the wider framework of this book. Art we described—rather patronizingly perhaps?—as one of mankind's major achievements, and quoted the dictum that that same Art was no more than the result of man in action. But that is a generalization that can be misleading; although to say this is not to suggest that anything produced should be gratuitously ugly, yet it is true that when we think of the result of men's work, of *Production*, we are not thinking in terms of Art. We are being much more workaday and practical.

Nevertheless we are thinking definitely of Achievement. Work may be the Curse of Adam, but by all that is marvellous how we have reduced it! How largely have we conquered it since the times when the Cave Man took a day—a week for all we know—to sharpen his flint to perfection, or even since the slaves of the Pharaohs sweated to roll blocks of stone to make their master's pyramid! We will, then, look at Production and the growth towards the modern methods of trade and industry as a series of *conquests*.

The Control of Energy or the Conquest of Power. The following has been written (it is from a book quoted at the end of this chapter): "it may be said that in its widest sense on its material side history is the story of man's increasing ability to control energy". To do anything, the author explains, men need energy, whether it be the energy supplied by food or the energy supplied by fuel. And where that energy is to be found, geographically, has always had a fundamental shaping effect upon men's lives and history. To point that, one only needs to think of coal in the nineteenth century and uranium, for atomic energy, now and for the future.

The Conquest of Power is a slightly narrower way of saying the same thing: put the hard drudgery on to the back of the machine! And it is of course not only in the workshop and the mine that we increasingly do that—as anyone who has harvested a whole field with a hand sickle would undoubtedly tell us.

The Conquest of Hunger may in fact be called another of man's aims, to which he is helped by the conquest of power. He has not perhaps been so successful here, and is in danger in fact of losing ground: rapid human proliferation threatens to nullify and more than nullify the advances made by the agricultural chemist and his like. Agriculture is still the world's biggest industry and is obviously likely to remain so. It is worth remembering too that anything approaching knowledgeable and scientific use of the land is as recent a thing as is the steam engine—in fact the names of such men in England as Coke of Norfolk and "Turnip" Townsend are as important as those known to every schoolboy, Watt and Arkwright and Stephenson.

Man's three fundamental needs are for food, clothing and shelter; and the successful fulfilment of the last two of these might be called the Conquest of Climate. That brings us back to the arts of architecture and of fashion. Do not despise the art of fashion or the whole business of wearing clothes. It may be artificial, but that does not prevent its having significance. Many books have been written upon the psychology of clothes: clothes alter our look, and our apparent shape, and so our own feelings about ourselves. There is this connection, too, between how we clothe and how we shelter ourselves, that is to say how we build our towns and heat our houses: until all this is a good deal more cleanly done we cannot very well go back to the bright, beautiful flowing clothes of previous ages. A history of fashion is a remarkably pointed commentary on the history of the wearers of those fashions.

Conquest of Materials is another useful way of looking at man's achievements. We are becoming reasonably successful at that. For material can be remarkably recalcitrant—as anyone who has felled a tree or watched a blacksmith will know. But watch on the other hand a giant machine tool pare away steel like cheese, and you will realize what progress, for good or ill, has been made there. We begin, too, to be less dependent upon the natural products, wood, wool, cotton, leather, and to create *synthetics* instead. Even so of course we are still fundamentally dependent upon Nature. But it is not a direct dependence. You create a material more amenable, more exactly what you want; and you do not have to wait for it to grow.

Lastly, and perhaps most significant of all, the Conquest of Friction—of Distance—of Space. More and more, and more and more rapidly, we move ourselves and our merchandise about the world.

Take merchandise first: we have arrived at Commerce.

Now commerce is undoubtedly a most paying thing and a most romantic thing. That juxtaposition is intentional, because it is very easy to feel that the one destroys the other. Perhaps it does at times. But commerce, trade, the moving of goods from where they can best be made to where they are most wanted, besides being rightfully a paying thing because it is so obviously a *beneficial* thing, has also created, more than has any other single influence, the adventurer, the traveller and the sailor. Their names resound through history—from Jason after his golden fleece, through Marco Polo, favourite of a fabulous Emperor of China, to Drake rounding the Horn and visiting an island that has now disappeared for ever beneath the surface of the sea. The early Greeks, the Renaissance Italians, our own Elizabethans, were fine, live men, the salt of the earth in their times; and they all throve on commerce.

Trade means transport. Hence that somewhat cryptic phrase, the Conquest of Friction. For it is not too fanciful to describe the gradual evolution of better methods of transport as a gradual conquest of friction. The most primitive method of pulling is dragging. Then rolling. Then comes the wheel on an axle—even up to the time when the Spaniards arrived the Aztecs had not reached so far as that. Then power to the wheel. At the same time the ship gradually evolves. For a long while it only uses the wide rivers or hugs the coasts. Even when it crosses the oceans it cannot at first carry much in the way of bulk; the accent is therefore on the precious cargo—the spices of the Indies for instance. Then power, too, to the ship. Then refrigeration—a great step forward for commerce and all due first, it is said, to the brilliant idea of an Australian who read of mammoth meat being found still edible in Siberia. . . .

And finally air transit. That moves goods—perishable goods, goods in a hurry—but it also moves people, significant people, Very Important People. That, with tele-communication, has made the world *shrink*. To say that has almost become a cliché; but nevertheless it is a tremendously significant fact. We are all interdependent now, mutually affecting one another. The sovereign nation begins to be an anachronism.

This virtual shrinkage of our world is one effect of modern material progress. Two others are worth mentioning, and then we can close this brief chapter which does no more than draw attention to a few outlooks or points of view.

One is a corollary, or rather perhaps a limiting factor to that conquest of power which we said put the burden and drudgery on to the machine. It does not do so *wholly*; we do not get the whole benefit. For Complexity comes back and spoils the beauty of the picture. Part of that complexity is the proliferation of wants—the three fundamentals, food, clothes and shelter, seem of minor importance!—and so we send men and women back to the bench and the desk and the machine for long hours to produce anything from television sets to football coupons. (This is not to say in the least whether such things are desirable or justifiable.) But there is another form of complexity too, the complexity of bigness in business (whether of State or private enterprise), the complexity of control that that bigness necessitates, the complexity of paper-work, of accounting, of correspondence, of statistics and the rest. That negatives quite a large proportion of the benefits of the machine age. Half of us do not produce; we go to the office. . . .

The other effect is allied to this. If men and women work in offices, or mind machines, will they be the same sort of people as their forebears who went to the fields and who minded the crops or the cattle? Of course they will not. Can the townsman be the same as the countryman, the proletarian the same as the peasant? Of course he cannot. Just as Man is influenced geographically by where he lives, so he is influenced historically by when and how he lives. He will think differently, act differently; his desires and ambitions and loyalties will be different, his view even of himself—his *persona*—will be different.

Descriptive Economics (with a dash of history and a glance at commercial geography) have brought us round to Psychology. Which is not inappropriate. For it is always men and women, and not things, that matter.

BOOKS: The quotation about energy was from *Geography and World Power*, by James Fairgreaves (University of London Press); that, or *About this Earth*, by F. Kingdom-Ward (Cape), can well serve as an introduction to Commercial Geography.

But the main recommendation for this chapter is H. G. Wells' *Work, Wealth and Happiness of Mankind* (Heinemann), which is the third of a great trilogy of which the other two are *The Outline and History* and *The Science of Life*. It is stimulating if not by any means orthodox, and it covers a great deal besides descriptive economics.

CHAPTER XX

THE RULING AND CONTROLLING OF MAN

(Law; "Civics"; Government)

"1. If a man weave a spell and put a ban upon a man, and has not justified himself, he that wove the spell upon him shall be put to death.

"2. If a man has put a spell upon a man, and has not justified himself, he upon whom the spell is laid shall go to the holy river, he shall plunge into the holy river, and if the holy river overcome him, he who wove the spell upon him shall take to himself his house. If the holy river make that man to be innocent and has saved him, he who laid the spell upon him shall be put to death. He who plunged into the holy river shall take to himself the house of him who wove the spell on him."

What, you may well ask, is that? It is the first two laws of the first Code of Laws ever known to have been made, that of Hammurabi, King in Sumeria over four thousand years ago. We may agree that we have progressed a long way from the harsh cruelty and rough justice—not to say superstition—of those laws.

Then there is this from the laws of Moses:

"Ye shall not eat of anything that dieth of itself: thou shalt give it unto the stranger that is in thy gates, that he may eat it, or thou mayest sell it unto an alien."

We have progressed somewhat beyond the naive exclusiveness of that.

But then read the third of Hammurabi's laws:

"If a man, in a case pending judgement, has uttered threats against the witnesses, or has not justified the word that he has spoken, if that case be a capital suit, that man shall be put to death."

Or read Deuteronomy xxiv, 16, and xvi, 19:

"The fathers shall not be put to death for the children, neither shall the children be put to death for the fathers."

"Thou shalt not wrest judgement: thou shalt not respect persons, neither take a gift."

Those, old as they are, have an amazingly modern sound (except of course for the harsh punishment of the first). Indeed our minds fly at once to the "justice" of Nazi Germany. Have we after all progressed so far or so safely?

Those quotations begin this chapter for two purposes: to show how old is the idea of, and the need for, law and justice, and to remind ourselves both how precarious our hold on them can be and how terrible the consequences if we do lose that hold.

Later in this chapter we shall be reviewing the system of law and government of this country, because we ought to have some knowledge of that and most of us have very little. (Which of us for instance knows for certain who is who of the functionaries, begowned and bewigged, of a formal Church Parade?) But first we must have some ideas of the theories of law and of government. Why and how did the two grow up as they did? Why in fact did they have to grow up into existence at all?

Our knowledge of early history and pre-history, even of biology and anthropology, is going to help us here.

For think of Man as a species. He is not like the ants, not in the least like the instinct-ridden ants. He is not in fact by inherent nature a "social animal"—he is much too highly individualized. And yet his reason and his good sense tell him that it is not only expedient but right and proper to live in societies of mutual help and respect of other individuals.

In an earlier chapter we spoke of primitive man finding his big and imaginative brain, superimposed as it was on his very animal nature, almost too difficult for him. It is only to shift the emphasis to say that his first great and difficult task was to *discipline* himself—discipline himself to live safely and harmoniously within a community. Take for instance the whole business of sex. How to avoid promiscuity, and incest or the marrying of near relations? With amazing uniformity primitive men seem to have found a very drastic cure for that: *exogamy* or marrying out—outside one's tribe that is to say. To do anything else was strictly *tabu.*

We must bring in that word *tabu* again because it leads very conveniently to a rather sweeping generalization which we are going to make.

For with *tabu* goes *custom*. And this is the generalization: in primitive societies custom takes the place of law. One even might go further, and say that custom largely takes the place of both law and government.

If there is no law and no policeman, what is the force, the "sanction", behind this so-called custom? The answer is, largely the sanction of religion—not often a very high form of religion, but the best they had. One simply does not offend the Gods.

Custom can make government hardly necessary for something the same reason. For to have a community where all obey implicitly the same rules is to give that community cohesion—*conscious* cohesion and a feeling of unity. And that is one of the things that men have only very slowly learnt: that any society, to be healthy and to continue to exist, *must* have a binding force and that that binding force is largely common custom and common belief and a commonly accepted standard of what is right and wrong.

When, comes the next obvious question, does custom change to law and government? One generalization is to say, with the coming of agriculture and of the ensuing first villages and cities. For personal property came into the picture—whether it be in slaves or land. Such problems as this arose: "If I dam up my part of the river am I responsible for causing drought to the man lower down—have I not a right to do what I like with my own?" Perhaps it would be truer to say that if men were to progress at all the gradual change from custom to law had to be made. Rigid custom may engender a peaceful and apparently contented society, but, since nothing can stand still, its customs are likely to get sillier and more and more out of tune with reality and those who obey them less and less amenable to reason. When Captain Cook asked the chiefs of Tahiti why they ate apart and alone they replied, "Because it is right," and could not see that there was anything more to be said about it. And no doubt the Dyak head-hunters, if you had had the temerity to ask them, would have given the same answer, or the bearded elder who bit youths on the chin at their initiation ceremony that they too might also be nobly hirsute: "we do it because it is right".

Here in fact are the lessons that we can draw from these few paragraphs before going on to the theory and practice of modern law and government. Man by his nature needs both law and custom to bind together his society and to keep it healthy. Custom should not be despised because it appeals to no sanctions other than the conscience and sense of fitness of the individual, but it must be constantly watched lest it grow stale. Law will in the same way only be good law if it appeals to a community's sense of justice and morality—if, that is to say, it is enacted not because it is expedient but because it is *right.*

As for Government, perhaps we hardly need tell ourselves that it is necessary. It is rather that we should keep our minds open to two things. The first is that the *size* of government is certainly not set by Nature: it need not be national, in some or many ways it may be better conducted on either a smaller or larger scale. And secondly, government is not an end in itself. If we could fit ourselves for less government it would be a step forward not back; when the Greeks with their enquiring minds invented the word An-archy or No-rule, they were not necessarily thinking of something bad.

Someone has said that the Greeks "broke through the hard cake of custom". They certainly had enquiring minds, and they gave us the terms which we still use in theorizing about Government. These we will look at for a moment. But in looking, remember this: their set-up, of the small city-state, was extremely different from ours; there, if you left out the slaves and helots (which you did), all citizens really could gather in the market place and have a personal say both in Law and Government.

There could be Tyranny they said; and they did not mean something necessarily evil by that.* The Tyrant *could* be a benevolent despot; the trouble was that he probably wouldn't be. Then there was Oligarchy, rule by the few, Polyarchy, rule by the many, and Anarchy. They argued about the respective merits of rule by the many and the few, and the world has argued ever since and come to no definite conclusion. The Greeks used another word too, not *arkho* rule but *kratos* power. And they talked about Plutocracy, or power wielded by the rich, and Democracy, power wielded by "Demos", the crowd—the ordinary, the unprivileged people, and so the poor. The essential contest, they said—or at least Aristotle said—was always between power in the hands of the rich and power in the hands of the poor and common people. And perhaps again they were right. They also said, many of them, that the ideal was Aristocracy, or power in the hands of the Best.

Now let us leave the Greeks, leave history, and ask ourselves what do we ourselves do and think in these times about the theory and practice of government.

One thing is obvious: our numbers make the Greek idea of

* The Greek word "Tyrannos" really meant no more than an absolute and self-appointed *King*; the play *Œdipus Tyrannos*—already mentioned in our Psychology chapter—is translated into Latin as *Œdipus Rex.*

democracy impossible. We have had to invent voting and *representation*, and a very small percentage representation it is at that: it is a "democracy" which the Greeks would not have recognized as such.

And yet we are very proud of it. Our national history books are full of it, of the struggle to get where we have got to in good government—Magna Carta, Habeus Corpus, no imprisonment without trial, no taxation without representation, Mother of Parliaments, and the rest. Indeed at school we get more than a little tired of it—which is a pity. Let us see to what we have arrived in our own particular country. We have:

A King or Queen who is a well-loved figure-head, a steadying influence and a guiding force, but who in ordinary practice has little or no direct power.

A Parliament, or Legislature (meaning law-making body), consisting of a House of Commons put there by popular vote every five years or less, and a House of Lords, so far purely hereditary but again with no great power beyond that of making the lower House think steadily or cautiously or think again.

A 'Party System' whereby one of two or sometimes three parties, so long as it has a majority (even a small majority) of elected numbers, takes over the whole business of government. If the people do not like its policy, however, it does not need a revolution to turn it out but only a new election. (That is important.)

An Executive (meaning the people who do the real governing and shaping of policy) which is taken from the outstanding members of the Party in power and chosen by the leader of that Party to form a 'Cabinet' under him as Prime Minister.

A Judiciary (meaning those who administer justice) which is a permanent and steady institution standing outside politics, though actually headed by a party member of the Cabinet, the Lord Chancellor, and with all appointments (though not dismissals) virtually in the Prime Minister's hands.

A Civil Service (as the lowlier part of the Executive, performing the day-to-day administration). It stands entirely outside politics and is in no way dependent for appointment upon the Prime Minister of the day; it is by tradition incorruptible and owes allegiance to the Prime Minister and Cabinet Ministers in power, whatever their political colour. Its activities and its use of public monies are under searching control by Parliament.

Now there is a great deal about all this that is hopelessly illogical. There are our kings for instance, who on paper are hardly kings at all. Or take the business of the Cabinet which the Prime Minister appoints. Firstly, it is nowadays only the senior ministers who are in the actual Cabinet or minister-meetings at all. Secondly, a man may be put in charge of a Ministry, or office of Civil Servants doing a particular job, and have no technical knowledge of that job at all. And thirdly, it is really hard to say whether this body of ministers is popularly elected or not, since all or any of them can be members of the House of Lords or can indeed be created Lords for that very purpose, and it is only the Prime Minister's observance of tradition and custom that has prevented unfair advantage being taken of this anomaly.

That indeed is really what we in Great Britain proudly stress: our Constitution is an unwritten, and so a flexible, one, and our institutions in general are sensible and flexible too, just because they are not cut-and-dried and wholly logical but conform to what we might call both the waywardness and the innate common sense of decent human nature.

And that is largely true. As a whole it does seem to have evolved itself very well. It is a proud fact, too, that ours is called by the world the "Mother of Parliaments" and that, during the nineteenth century at least, many nations copied it. But do not let us, on the other hand, be too complacent! It is rather too easy to be proud about being illogical and to claim that "it works well in practice anyway". The American system is, for instance, basically different in many ways from ours. Their constitution *is* a written one. The great theory of its framers was that "Executive" should be divorced from "Legislature", so that the Cabinet does not come at all from the two Houses of Parliament (the House of Representatives and the Senate) and cannot indeed sit in either. There the two Houses and the President are each elected at varying times and on different systems, so that a President may have a "Parliament" of the opposite party to himself. That is illogical; and yet, says the American, it works. But both countries cannot be wholly right with their illogicalities. . . .

The real fact, indeed, to get into our heads is that, though the theory and practice of government has progressed a good long way since the tyrannies and terrors and usurpations and injustices of an early Eastern potentate or a later Roman Emperor (and quite apart from the fact that, as the last decade or two has taught us, it can slip back horribly at any moment), yet it still has a long way to go before it reaches perfection or anything like it.

How to govern ourselves is obviously about the hardest lesson in sociology to learn. Let us at least, before we leave this rather depressing idea, notice two fairly obvious criticisms of our own present brand of Democracy. One is Stalin's: that you can't very well call it

Democracy when nearly half the electors—perhaps on occasion, as our voting system goes, even a little more than half—have no say in their government at all and have indeed voted for something as different as possible. There is of course the irritated retort to this, "Well, your system is a darn sight worse!" but that hardly gets rid of the argument. If that minority is a selfconscious and extremely different one (as in some parts of India for instance in matters of religion) there is real danger of injustice to them at the hands of an intolerant majority.

A deeper criticism of our system of electing our rulers by popular vote is that unless the voters are very sensible and very knowledgeable and very well educated they will be swayed in their electing by very silly reasons. In other words, you get the *politician*, which is something less noble than the statesman. You get the demagogue, or the man who "leads the crowd" and uses, or rather misuses, that marvellous, that terrible power of the uttered word to sway beyond reason. *Education*, you may say, is the cure for that. But then that is an easy word for a difficult thing. There is most certainly good reason for remembering that we have not yet reached perfection in the science of government. . . .

Now let us leave theorizing to say something, shortly and categorically, first about this country's judicial system, and then about Local Government.

As citizens we have obligations to all of our fellow men. These are of two sorts: to our fellow men as a group or society, and to our fellow men as individuals. If we have failed in the first we are likely to have contravened the *criminal* law, and to have committed a felony or a misdemeanor; if we have failed in the second we have put ourselves within reach of the *civil* law, and have probably committed a "tort". You may of course do both at the same time; if you ride a bicycle without a light and run into and injure somebody, you are liable to be summoned by the Queen's Officers because you have broken a law devised to protect society, and you may also be sued under Civil Law by the particular person you have injured. Of course, if you murder or steal you do harm to an individual, but there is the wider, social aspect too and you are indeed "a criminal". If however you fail to pay your grocer's bill or to fulfil a contract that you have made, then there is only one person you have greatly harmed and it is up to him to set going the machinery of the law.

One other general point about Law. There is Common Law and there is Statute Law. Statute Laws are those passed by Parliament. Once passed they stand for good, unless repealed—if you are guilty of Treason it is an Act of 1351 that will bring you to book. Common Law may go back even further; but it is on no statute book, it is *precedent*, built up from past legal cases going right back through our history. It results from Judges' decisions and interpretations, and is still the subject of Judges' interpretations. Both grow as time goes on; and Statute Law has tacked on to it all the "Statutory Rules and Orders" that Government Departments are allowed to make (some people think too freely, though the powers thus given are always covered by an Act of Parliament and so, at least theoretically, are repealable).

Each kind of law has its own series of Courts.

The Civil series is the simpler. If the monetary value in dispute is—with, as one nearly always has to say in these matters, certain exceptions—under £200, the case will be heard in a County Court presided over by a County Judge. If above that amount it will be heard under a Judge in the High Court. This High Court always sits in London and is divided rather curiously into three divisions: first, Probate, Divorce and Admiralty, one might say dealing with the validity of wills, the dissolution of marriages, and the difficulties of the sea; second, Chancery, dealing largely with estates of "infants", trusts, land and property; and King's Bench, dealing with everything else.* From any of these Courts there is appeal to the Court of Appeal and beyond that to the House of Lords. To go through all that will of course be expensive—though the worst injustices of being too poor to go to law have been removed now that the Legal Aid and Advice Bill of 1948 has become law. It is worth remembering here, incidentally, the difference between a barrister and a solicitor. The solicitor is rather like the G.P. in the medical profession, and the barrister the Specialist. The layman consults his solicitor and the solicitor "briefs" a barrister to plead for his client in the Court. A solicitor has to know all the law (or know where to look it up); the barrister is the free, specializing, skilled advocate. It is from the ranks of the barristers that the Judges are chosen.

Now for the Criminal Courts. First comes the Court of Petty Session, sometimes called the Police Court but more accurately the Magistrate's Court. Here magistrates sit (usually two or three at a time and with a Clerk to help and guide them). As is well known, the ordinary magistrate (Justice of the Peace—J.P.) is unpaid and not an expert but merely a local man of standing: a curious, very English system which most people think might in practice be a lot worse, and which still works reasonably well—the man of standing is assumedly also sufficiently a man of culture to be able to take the judicial view.

* This is something of an over-simplification. Actually, all three Divisions are equally competent, and a plaintiff may start his action, within limits, in whatever Division he likes; the distribution of business in practice is directed by the Lord Chancellor from time to time.

The limits of this Court are not governed by money values but by seriousness of offence, or in some cases by whether the person being tried expresses a wish to be tried higher (that is to say, *not* by the local man who may know him only too well).

Next comes *Quarter Sessions*, presided over by senior magistrates. After that comes the *Assizes*. And from both these there is appeal to the Court of Criminal Appeal and from there, exceptionally, to the House of Lords.

Assizes are important things. They take place four times a year in County and other big towns; and the Judge comes round in his "circuit" with all the panoply and awe of Majesty behind him, just as in the past in this and other countries the King himself travelled round his kingdom to see justice done among his subjects.* No crime is too big to be tried at any Assize—London and the Home Counties merely have their own equivalent of an Assize, sitting permanently at the Old Bailey and called the Central Criminal Court. All crimes, on the other hand, at least start their hearing in the Magistrate's Court of Petty Session.

And how about Juries, that rather curious but again practically successful method of being tried by our "peers" or equals? Put shortly: on the civil side the decision as to whether there shall be a jury is made in each case at the time of the hearing; and on the criminal side there is always a jury in the higher Courts, that is to say at Quarter Sessions and Assizes.

Unfortunately, there are some exceptions to a great deal of what has been written above. By and large, it is the growth of big towns that has made the exceptions and spoilt the simplicity of the scheme from the point of view of exposition. The same applies to Local Government, as we shall see. For our law and our government have grown up from Mediaeval times when things were simpler, more homogeneous, and more rural. In towns nowadays there are Stipendiary or paid magistrates, since you need an expert whole-timer with legal qualifications, and are not likely to get a good one for nothing. Towns, too, have Borough Sessions, the equivalent of Quarter Sessions; and there a paid, full-time, and legally qualified "Recorder" sits.

Now Local Government. What is its job? It is "running the show" locally—parish, village, town and county—in small things quite independently, in bigger things under the guidance and control and with the financial help of the Central Government. This, too, has a

* One might say that it is more than merely representing majesty. There is the story of two Victorian Assize Judges at some function in their honour. One rose when the Queen's health was proposed—to be dragged down by the other, with the adjuration, "Sit down, you fool—we *are* the Queen!"

step-ladder of importance of function, and once again the simplicity is spoilt by the growth of the big towns.

On the country or rural side it runs: Parish Council; District Council; County Council. The parish—a very ancient but still a live division—will comprise one or more villages; and if the electors (householders and their children over twenty-one years old) number less than three hundred there are "meetings" and not councils and *every* elector may attend—here at least we are back to the Greek idea.

Now when you come to the towns the three-tier system disappears. The medium-sized town has an Urban District Council, which is the equivalent of the Rural District Council, and the bigger town—unfortunately we cannot give population limits because there are too many exceptions and anomalies—has a Borough Council. Both these have one thing, their County Council, above them. Finally the really big towns are County Boroughs, and are in straight line with the Counties themselves. There are at present eighty-three of these County Boroughs—apart from London whose County Council covers so huge a population that it is as big as some sovereign national governments and has an importance and rules of its own. It is incidentally an interesting comment on geography to note how these County Boroughs are grouped: in industrial Lancashire and Yorkshire and the Black Country, and round the coast and river mouths.

The people you elect on to Councils are called Councillors—Parish Councillors or just Councillors. They will elect a Chairman, unless it is a Borough or County Borough, when they will elect a Mayor (or in twelve large towns a Lord Mayor). Where there is a Mayor the Council will also elect not more than a third of their number—including some co-opted outsiders if they wish—as Aldermen. Even the electors here will have a grander and more romantic name: burgesses, making one think of Lady Godiva or the Pied Piper of Hamelin, local government being undeniably historic.

Finally, and importantly, what are the activities of these various councils? They are, as one can imagine, multifarious, the work being done by splitting the councillors into Committees, with naturally any one councillor on more than one committee; a County Borough may have twenty or more committees. Any short generalization will do an injustice. But one can put it like this:

$$\text{COUNTY}\begin{cases}\text{Education}\\ \text{Police}\\ \text{Health}\\ \text{Highways}\end{cases}$$

DISTRICT { Housing
Sanitation

PARISH { Playing Fields and Allotments
Street Lighting
Public Footpaths, etc.

Remember that sometimes—indeed most often in terms of population—these three Councils get concertina'd into two or one. Where there are two or three, however, the junior does not necessarily have to obtain permission of the senior; indeed rather is it the other way round, with the junior having some powers of criticism of and representation to the senior.

But the best way to realize what is being done for you as a citizen of village or town or county is to look at the back of a rate demand, which shows in terms of percentages how the money collected will be spent. Education will very likely be the biggest charge—that is a tremendous enterprise now, covering all technical as well as school education, and a costly one too. Health and sanitation has always been an important item; in fact it was the simply appalling sanitary conditions of the suddenly and rankly growing towns of the North in the Industrial Revolution that, with the backing of many noble and disinterested workers, gave local government its great impetus.

And that is the next point to appreciate: that, apart of course from the whole-time officials, Town Clerks, Officers of Health and Education and so on and their staffs, this is all voluntary and unpaid work. That is no doubt as it should be. But those who grumble when they pay their rates are apt to forget it. They are apt to forget, too, that if in fact there is any truth at all in that other grumble, to the effect that mediocrity or self-seeking serves only on the Councils, it is the body of electors or burgesses who by their indifference are creating that situation. You will find in any book on local government, and in many other places, that same warning: that very few bother to take interest or trouble to vote, and that there is a consequent danger of central government finding itself forced more and more to take over from local. How the Greeks would have laughed if we could have told them we had local democratic self-government and they could then have seen how much time and energy the average citizen afforded it all. . . .

If we turn for a moment to the financing of all this we can conveniently bring it—very cursorily—the finances of central government too.

Taxes afford the money for the expenses of central government and rates the money for local government. Rates, therefore, you might call local taxes. There is this difference however: that whereas the amount of tax you pay depends on the size of your income, your rates depend on the value of your house. Nor is it strictly true for that matter that taxes depend upon income; it is only directly so with income-tax and sur-tax. For "excise" duties—beer and tobacco for instance, and the long range of Purchase Taxes—you are only likely to pay more if you are rich because you will have more money with which to buy the excisable things. It is one of the theories (rather obviously) of good taxation that it should be borne by those who *can* bear it; and that is why taxes on goods-to-be-bought are usually looked on askance by theorists. Certainly it is not fair to tax the necessities of life upon which the poor must spend a much larger proportion of their income than the rich.

Another theory of taxation is that it should be imposed where it hurts the least; and yet that is not necessarily an advantage when looked at from a wider angle. For the more unthinking of us will then have no conception of where the nation's income comes from and will grow to think that the Government's pocket is indeed bottomless and to receive any financial help from it with scant thanks.

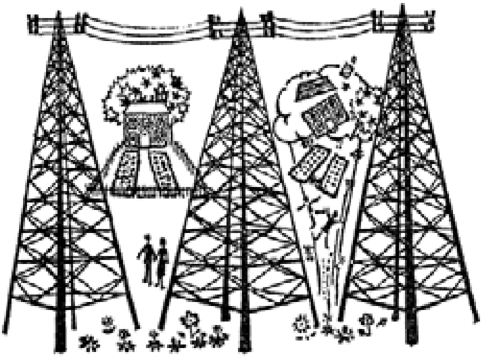
The real thing to realize about taxation nowadays is that it has become virtually a colossal machine for swapping round income. Taxes in fact often come back to the people who pay them, but in other forms. We do not, for instance, tax the necessities of life but actually subsidize them. At the moment of writing for instance, every time you buy a loaf it costs the Government a good deal more: father's ten cigarettes a day perhaps just supply about enough tax to pay for his family's bread bill. Then most tax-payers get some of it back because they own War Loan or Saving Certificates and receive interest on them. With rates it is of course the same: the very student who receives a Government grant may find he has to pay highly for his lodgings—and one of the reasons for that will be the high rates that his landlord pays. We are back once more to the old hard rule: you can't get something for nothing.

Nor in paying taxes and rates do we get nothing in return for a very substantial something—as some people are prone to think. Expenditure, both local and central, is very jealously guarded by those we elect to represent us. We have talked of the Councils' various committees; and, though we have not found space to mention it, Parliament works quite largely by committees too. And in each case the financial committee is an extremely important one. Each Ministry of the central government has to make very close estimates of its expenditure each year, and will find it very hard to get permission to exceed it. Governments have been turned out because their yearly forecast of expenditure, or Budget, had displeased the majority of Parliament. As for local government, it bases its methods pretty closely on central government. Added to this, where it receives "grants in aid" from the central government to help pay for the services it gives, as in Health and Education, it will also have on its tracks the inspectors and auditors of the Government Department concerned.

So much for Central and Local Government. We have perhaps given ourselves indigestion with too many facts. Let us then come to an easier finish by seeing if we can now recognize the dignitaries of that Church Parade we referred to much earlier in the chapter.

The Church Parade before the week of Assizes is likely to be the most resplendent of all. Then there will be the Judge in his heavy wig and robe, and his attendant officials. The Mayor and the Aldermen and Councillors will be there. The Head of the local Police no doubt will have his place—we do not have a national police force (which is significant). The man in the comparatively insignificant wig will be the Town Clerk or Clerk to the Council; he will be a lawyer, able to give advice to the Council on demand, but his other job is virtually to be in charge of all the local office staff. Finally, two other functionaries will almost certainly be there: the Lord Lieutenant of the County and the Sheriff. With them we are back in history. The "Shire Reeve" goes back to Saxon times but the Lord Lieutenant only a mere four hundred years. Yet their offices are by no means yet sinecures. The Lord Lieutenant is the Queen's representative; he still appoints the Justices of the Peace. As for the Sheriff, he "attends" on the Judge and is responsible to him on his circuit as a host is to a guest. The Sheriff has also some grimmer duties: he prepares panels of jurors and is responsible for the custody of prisoners and the carrying out of death sentences. As in the United States, though not so romantically as on the films, the Sheriff's name is coupled with lawlessness and the suppression of lawlessness.

BOOKS: Two booklets to be recommended here are both published by the *Bureau of Current Affairs*, now unfortunately defunct. Copies, however, are probably available in most libraries. They are: Pamphlet No. 21, *The Law of England*, by Ernest Watkins, and the Handbook, *Local Government in Outline*, by Frank Jessup. There is also a more advanced book, *The Government of Britain*, by Wilfred Harrison (Hutchinson's University Library).



CHAPTER XXI

MAN CONQUERS MATTER

(Electricity; Electronics; Atomic Energy; Relativity)

AFTER a couple of chapters on some aspects of the "social" sciences, and before another which is something in the same vein, there is sandwiched here one that is very different, dealing with the material sciences. One is tempted even to stress the differences by saying that one of these at least threatens to be an extremely unsocial science.

That in a way is why this chapter is put here. The previous chapter, one might say, dealt with Man's efforts to control and conquer himself. Now in his path of controlling Nature he has taken easily the biggest step forward so far, that of "splitting the atom"—and the very fact that he has done so endangers this control over himself. It is the old story, as H. G. Wells put it, of the child with the revolver: if we cannot control ourselves and our more childish and animal and primitive propensities, then the more we control Nature the more dangerous we become. It is a favourite pastime to give ages a name, the Iron Age, the Steam Age, the Motor Age; but that we are stepping into the Atomic Age is surely a legitimate generalization. And that is of supreme importance. This chapter, therefore, seems definitely to fit in here—before, as a finale to the book, we look a little at the ways in which mankind does try to achieve wisdom and the kinds of knowledge he seeks to acquire to help him to do so.

Now the science of Electricity is not the science of Atomic Energy, that is obvious. But the two do go together, if only that some of the discoveries in the first have helped towards discoveries in the second. This chapter will start with the first, will proceed, with a passing glance at Electronics, towards the second, and—after a cheerful, but justified, reminder that control of the energy within the atom of matter does not lead only to the manufacture of bombs—will consider the propositions of two great scientists, Max Planck and Albert Einstein, whose theories derive in whole or part from a consideration of how the atom behaves.

We shall find ourselves occasionally considering quite practical details. But we shall soon and resolutely sheer off from them again. There are many books that give those. We are trying to get a grip of the fundamentals of these things—or, to put it more humbly, to grasp if only as it were by the crook of a finger what in everyday understandable language or analogue it is all about. It is not easy. But it is worth while: something can be done at least to cure the inferiority complex that goes with complete ignorance.

What we learnt about the atom is a long way back in this book. It will therefore be best as a start to put down, categorically and without troubling to remember whether we repeat ourselves or not, what is the minimum that we need to appreciate. Here it is:

1. The atom and its constituents are of an order of smallness beyond any other order of smallness.

2. When we assert that the atom is this, that or the other, we are, it may be said, only guessing; but they are very good guesses borne out by a number of incontrovertible facts.

3. The atom is largely emptiness.

4. It is composed of a nucleus, where nearly all the mass resides, and of electrons gyrating round the nucleus, often in complicated orbits.

5. The atom of each chemical element differs from the atom of all others. It differs by the number of electrons revolving round the nucleus.

6. Whereas the nucleus is, one might say, wellnigh inviolable, the revolving electrons are not. Indeed some are the very opposite. Comparatively speaking they can be "knocked out" of their orbits with ease.

7. Normally, and so long as the revolving electrons are not knocked out and away, the atom is *in stable equilibrium*. But not so when some of the electrons are induced to depart. It is then out of equilibrium

and will remain so until it regains its full quota of electrons, and this it will try to do.

Now with that we have arrived most definitely at *Electricity*. In place of the expression "an atom out of equilibrium because it has lost some of its electrons" we can substitute "an atom positively charged with electricity". And for the freed electrons we can substitute the words "negative electrical charges".

That last is of course a pity. For it introduces a difficulty when all seemed simple. "Is, then," you may say, "an electron actually a negative charge of electricity? I thought it was a particle of matter!"

The answer is—again quite definitely, though it brings in the incomprehensible—that *it is both.*

There is no getting away from that. An electron is the final indivisible "brick" of matter; it is also the final indivisible ("negative") charge of electricity. Perhaps the only way to help oneself to believe or accept this is to remember that the electron is really quite unimaginably small in mass: thousands of times smaller than any atom, and there were, you will recall, a staggering number of atoms in a pin's head. . . .

Now, how do we get these electrons or negative charges of electricity to leave home and a hiatus behind them? The answer is by various means—chemical action, mechanical action, even simple rubbing.

Yes, even by rubbing! And there, as no doubt you know, we come to the most obvious manifestation of electricity and the first discovered. Once again the Greeks come into the picture and give us a word for it. They rubbed amber (with what we should call a non-conductor) and it attracted other such non-conducting particles. And the Greek for amber is *elektron*. The same sort of thing happens when you comb your hair or stroke a cat. The hair follows your hand or the comb; blue sparks even fly across.

What happens in terms of electricity? Simply that some of the electrons of the molecules of the thing rubbed have come off on to the rubber, or vice versa. The loser of electrons is "positively" charged and the gainer "negatively"—and remember that these two terms are only man-made for convenience; there is no plus and minus in Nature.* The two things so charged want to get right again, to get stable again—the word "want" ought perhaps to be in inverted commas, we are using it as one might say anthropomorphically—and if the force to achieve this is strong enough then a stream of electrons or an electric current (it is the same thing) will overcome the resistance of the air

* The scientists also talk of an electric current leaving a positive "pole" or *anode* for a negative "pole" or *cathode*. Those two often-used words are—perhaps not much more helpfully—Greek for "way down" and "way up" respectively.

and jump across, making the air momentarily incandescent in the process.

If there is no jump, then the charge will remain—a charge of "static" electricity.

It is easy to become muddled here, and to think that there is a fundamental difference between this static electricity and the electricity ("kinetic") that flows through wires and does our household work for us. There is not; there is a distinction only. In the rubbed rod we have created a charge that cannot get away; if we rubbed an iron rod it would get away at once, because a metal is a good conductor of electricity. What we have done is to tap a little of that outer energy of the atom inherent in the rapidly revolving electrons. But not *very much* energy—that is the next point to realize. Even if you invent a machine to do the rubbing for you and then let the charge out with a rush you haven't got anything very great. But it was soon discovered that certain chemical actions achieved a better result. After all, what is chemical action and interaction but a regrouping of atoms and an exchange of electrons? Put two different elements—zinc and copper for instance—in a weak acid, and the acid eats the zinc and does that necessary business of detaching the electrons and creating a "charge" in the process. What is more, if you connect the two ends of the elements that are not in the acid you get a *continuous* flow of these electrons; in other words you get an electric current.

That is simply what an electric current is: a flow of electrons set going to restore a stability of atoms which you have upset. That is the next great point to realize: that a flow of electricity always occurs and only occurs to put right an instability, or, in technical language, between two charges at different "*potential*". It is something like a flow of water between two reservoirs, one at a higher level than the other (think again of those Greek words anode and cathode). That is only a rough analogy; but it is a useful one, because it enables us to visualize—as we should—the Earth as electrically a great reservoir or sink. The Earth will always absorb or put right any instability or difference of potential.

Now why should some chemical elements or compounds be "good conductors" of electricity, letting the electrons flow easily, and some not? The answer is simply: their atomic structure, the arrangement or pattern of their outer electrons. That cannot perhaps be a very satisfactory answer. But it will help if you remember that all chemical facts must be thought of in terms of the different arrangement of the atoms—not only such things as whether certain elements easily combine, but the characteristics of elements and compounds, whether they are oily, or brittle, or shiny like metals, and so on and so on. Conductivity of electricity is one of many properties governed by atomic structure. Put simply it is this: good conductors have remarkably easily detachable outer electrons to their atoms.

And from that, as a digression, let us consider for a moment this business of the conductivity and the *danger* of electricity. First, if the flow of electrons is at all restricted—and it is to some extent even in a good conductor—it creates *heat* in the conductor. That is surely not surprising; heat is molecular activity, and after all the electron-flow is going to "jostle" the atoms considerably. The analogy of rash and headstrong people in a crowd is useful: the more rude and headstrong the jostler, or the denser or less accommodating the crowd, the greater "heat" is generated. So it is with an electric current; hence our electric fires, and, by raising to white heat, our electric lamps. But the flow will also heat—and, if strong enough, destroy by burning—the molecules of our own only-fairly-good conducting bodies. Electric current flows, we have learnt, between charges of different potential; the greater that difference—it is called *voltage*—the greater the flow, and so the greater the shock to our system if we put our body into the circuit. That is all there is to it. But remember two things: the Earth will always complete a circuit, very efficiently; and, secondly, water—in the bath, or even a film of it on our skins—is a good conductor. Perfectly distilled water is not, incidentally, a conductor, it being the mineral salts which do the conducting; but then we don't have perfectly distilled water in our bathrooms.

Back to theory. We are considering the ways in which electricity is produced. We come now to an extraordinary, and extraordinarily useful, property of an electric current flowing through a wire. It is this, that whenever such a current flows there is always round it—invisible, intangible, but none the less most potently there—a magnetic field of force. Put a piece of iron in that field, and it will tend to *turn* in the direction of the lines of that force.

We have come of course to *Magnetism*. Now magnetism was not first discovered as being the *result* of an electric current; on the contrary there came the early and romantic discovery of the earth's natural "lodestone" (leading-stone), and so of the mariner's compass. Nevertheless that is the real truth of it; the magnetic field is caused by a flow of electricity.

All this has tremendous practical importance—just because of that "alignment" or turning of the piece of iron. For there has been found a way of making electrical energy turn itself into physical movement, in fact of making it "do work". From this one phenomenon was developed the electric motor. (And if anyone wants to realize the implication of that invention—economic, social and so forth—he should visit a modern engineering shop where each machine tool now has its own individual electric motor and gone is all the maze of belting run from one big steam engine; it is a sort of emancipation.)

Not only that, but there was a reverse process. It was found that if on the other hand one *moved* a conductor of electricity—a piece of metal or, better, a coil of wire—across the lines of a magnetic field of force, then one had *created an electric current* in that conductor. As one discovery gave birth to this electric motor the other gave birth to the electric dynamo. And since *dunamis** is the Greek for "power" we come rightly to the Power Station and the fact that this mechanical means is easily the most usual method of generating electricity.

But leave now this utilitarian flow of electrons through wires. Electrons can also be made to flow through space. (That is, you remember, how we began, with the rubbing of amber; how Nature began it too, if you choose to think that way, with the lightning—a sort of healthy catharsis that purged and terrified Man to think with awe of Gods.)

Now we think less of Gods, and more of television and wireless sets, and radar, and photo-electric cells, and calculating machines that we call—with perhaps something of a return to that primitive awe—"giant brains". We leave electricity therefore for *electronics*—and it will lead us back to the atom and its splitting all in good time.

Though electrons will pass through air they obviously do not easily do so—there has to be a large difference in potential before the lightning flashes. But exhaust a glass tube of nearly all its air and try to pass a current or stream of electrons through that and, once you have stepped up the pressure or voltage, you find it can be done. One result is that the tube lights up with a beautiful violet glow—the beginning of all our fluorescent lighting.

This stream of electrons was called a "cathode ray", simply because it travelled away from the negative pole or cathode. Besides the violet light it was found to possess two other important properties. First, the "ray", it was ultimately found, could be both concentrated and bent. That was one of the things which made television possible—the main component of a TV set one might call a glorified cathode ray tube. The second property was what led to "X-ray"—and that must come a little later.

First consider a perhaps more obvious or easily accepted property of any flow of electrons, whether through a rarefied gas or along a wire: the fact that the speed is tremendous, of the same order in fact as the speed of light. That *speed* we have harnessed to do all sorts of

* A Greek "U" (*upsilon*), having been pronounced apparently like a French "U" or German "Ü", has usually now become a "Y".

things for us. It has afforded another link in the chain of technical achievements that made television possible, what is called the "scanning" of the screen or flat end of the cathode ray tube. Here a picture is formed in little squares of light and shade, one after another but so quickly that the eye gets the impression of a whole—not to mention that the eye also gets the impression of "moving pictures" by a quick succession of wholes. This speed also made radar possible. For radar is essentially judging distance by the time taken for an echo to travel. But since the echo is an ether wave or electro-magnetic wave (we had better use the latter name since scientists now prefer it) and not a sound wave, there is very little time indeed in which to count that echo.

Not only will the electron help you to count in terms of time, it will help you just to count, that is to say to calculate.

Here comes in, rather surprisingly, what we call the wireless valve and the Americans more disrespectfully just a "tube". Its discovery again arose from the observation of flowing electrons, this time that they flowed outwards from any piece of heated wire. This enabled an "alternating" current, a current that is rapidly pulsating backwards and forwards, to be trapped one way but allowed to flow the other. That is to say, it really had the property of a "valve", something that permits a one-way traffic only; the fact that by an elaboration—a "grid" of fine-mesh wires—this one-way capacity was also turned for radio purposes into a much more important *amplification* property is merely incidental.

With the electronic calculating machine the idea of a valve or "gate" is fundamental: you let an electric impulse through, either to be "registered" or to be "stored" until you want it. The great point again is however *speed*, something approaching the speed of light. In other words you count with electric impulses and not with cumbersome wheels and cogs.

But we talked of "giant brains"—why? It is really the storing-up process that justified the metaphor. In the electronic machine it is done essentially by translating the information that you want to have "remembered" into a closed electric circuit—and leaving it to travel round and round, like a white mouse in a treadmill, until you open the gate and let it out. And it is of course the word "remembered" that is the key word here. This storing up in an automatic memory is remarkably like storing something up in the memory of the human brain. Not only that, but the electric impulses that do it are remarkably like the impulses of our own nervous system. That is all there is to the analogue. There is nothing sinister to it. But it is thought-provoking. . . .

We can come back now to *waves*, electro-magnetic waves. The stream of electrons in the air-exhausted tube, we said, produced X-rays.

Röntgen, a German physicist, discovered this at the end of the nineteenth century. He put a screen covered with a chemical (whose name we certainly need not remember) in the path of a cathode ray. It lit up; there were also unexpected green flashes. Then by chance some unused photographic plates, wrapped against the light as they always are, were left near by. They were developed, and found to be fogged: a "ray" had been discovered that penetrated opaque matter just as light penetrates glass: Röntgen called the ray "X"—the unknown. There is no need to elaborate on the uses of that.

Remember now what was said of electro-magnetic waves at the end of the second chapter of this book. In increasing shortness of length these waves are called, we said: wireless waves, heat, light, ultra-violet rays, X-rays, gamma rays, cosmic rays. And all of them we believe, in a way analogous to that in which sound waves in the air are caused by a physical vibration, are the result of movements or vibrations of the molecules of matter or the atoms or the electrons that constitute those molecules.

These waves are indeed ubiquitous. To create a wireless wave all you have to do is to alternate a current backwards and forwards along a wire, and every time you change its direction there is a corresponding pulsation in that strange and ever-present surrounding field of force. But higher up in the scale something much more startling is happening: matter is disintegrating and being *changed into energy*. That is what we believe is happening in the sun; the same process—or possibly the reverse!—taking place somewhere in the universe, is causing cosmic rays; we split the atom, and so-called gamma rays endanger our lives (as would some of the other waves were it not for a protecting envelope in the upper air). In fact, as was also said in Chapter II, we now have to revise the laws of the conservation of matter and of energy: they become one law, that you cannot get matter-or-energy out of nothing, but that you can—it is not easy—get one from the other. One arrives in fact at this uncomfortable and supremely surprising picture of the universe, as a void of pulsating energy, with that energy as it were occasionally congealed into matter—gases, star-dust, suns, planets and all that is on them.

How then, we may now ask, did men sift out from all this overwhelming new knowledge of the real nature of the universe the power so to conquer matter that its final citadel could be disrupted and vast energy produced from its destruction? X-ray, radium, the speed of the electron all come into the story—and the great names in it are Becquerel, Crookes, the Curies, J. J. Thompson, Rutherford. It can only be told here with extreme sketchiness. And once again there is the necessity to start with a series of categorical statements about the nucleus of the atom:

(1) The nucleus, though about as small in volume as the outside-revolving electrons, yet comprises nearly all the mass of the atom.

(2) The nucleus always comprises the positive electrical charge of the atom, to balance and make equilibrium with the negative charge of the encircling electrons.

(3) As the atom grows in complication from the simplest, hydrogen, up to uranium and beyond, and as the number of outside electrons increases, so the charge and complication of the nucleus grow.

(4) So complicated and highly charged is the nucleus of some of the elements at the end of the atomic scale that they are *unstable* and continually disintegrate. These are uranium and radium in particular.

That last is certainly the most extraordinary. For the nucleus seems to have, as it were, an invisible armour, the field of force caused by its revolving electrons. Yet when we get to the end of the scale, with the greatest number of revolving electrons, we find instability. But it is an instability from within—it is as if the prisoner waited until his walls were thickest before he attempted and made good his escape.

Radium is more spectacular than uranium in its disintegration; though even so it takes 1600 years in which to lose half its mass. It sends out what are called *alpha* and *beta* particles and, as a result of this, that electro-magnetic wave which we have already mentioned, *gamma* rays. (These are of course merely names that have stuck, they are the beginning of the Greek alphabet used in the same experimental give-it-a-label-attitude, as was Röntgen's "X"-ray.) The gamma rays were found to be of very short wave-length and of very remarkable penetrating powers: it meant that the slowly disintegrating nucleus was sending out particles with spectacular force.

How to cause this natural but so slow disintegration to be speeded up and at the same time to be under control—that was the problem.

X-ray gave a lead. For it was discovered that those flashes on the prepared screen of the cathode ray tube meant that the bombarding stream of electrons was actually setting free—"knocking off" as we might say—other electrons from the screen itself. They were not admittedly the electrons of any atom's inner nucleus. But their behaviour gave birth to an idea, the idea of *bombardment*. Use the electron as ammunition and so break down the nucleus's defences—it was rather like pounding down a castle with its own stones. Indeed, the rest of the story of splitting the atom—let us be a little more scientifically accurate, of "achieving nuclear fission"—might be called the story of bigger and better bombardments. . . .

Yet how difficult! After all, how small was the target, and how virtually uncontrolled the barrage of electrons! It was hit-or-miss with tremendous odds on the miss. Many of the electrons could not even be made to reach the target at all. The first thing was to step up the punch behind them—to the tune of a million volts.

Then a big step was made, an entirely new type of ammunition. It was discovered that the atom nucleus contained something called a *neutron*, so named because it had no electric charge at all. To use that would be a great advantage over the electron, which often failed to reach its target just because of the resistance caused by its negative charge.

Uranium was bombarded with neutrons. The result was surprising. It was this: the actual splitting of the nuclei into (roughly) two halves, and at the same time the release of more neutrons to go on doing the splitting job. The whole trouble so far had been that a very great deal more energy was being put into the bombardment that was being got out by the very occasional release of nuclear energy. But now there seemed a chance of the reverse: if only you could arrive at a position where for every neutron harnessed to work for you you produced, by what is with obvious correctness called a *chain* process, even only a little more than one other neutron, then your result was cumulative and you had gone a long way towards solving your problem.

That in effect is what was done. And now curiously enough it was a slowing down of the bombardment that was needed. For reasons too difficult to summarize, either graphite or the isotope of water, "heavy water", were found useful here. Finally, yet another isotope was needed, the isotope of Uranium—"Uranium 235". It was the separating out of that from ordinary or natural uranium which was the last colossal job.

That is a sadly inadequate description. But perhaps it gives some idea. Before leaving atomic energy let us however do two things: one is to redeem that promise to show that there are many peaceful and constructive ways of using the new atomic discovery, and the other is briefly to explain "isotopes". The two go very conveniently together.

Shortly, an atom which is an isotope of any chemical element is exactly the same as the ordinary atom of that element in so far as its outer electrons are concerned but *not* the same in its nucleus; it is the same chemically but not atomically: its atom doesn't weigh the same. These isotopes exist in nature, but they exist rather more frequently after, and as the result of, man's atomic experiments.

Radio-active isotopes of a large number of elements are produced as a sort of by-product of this "chain process" of splitting the atom.

And it is these in particular which are going to be of great and varied practical use. They will be used as "tracers".

Now what do we mean by that? Simply that it is very easy to trace the minutest presence of radio-activity, whether it is within the human body, deep in the interstices of a massive machine of iron and steel, or in the middle of a cloud in the Heavens. Briefly, you "tag" or label what you want to label by introducing a little of a radio-active element; after that you can trace it where you will. That will help the weather forecaster and the engineer, but mostly it will help the doctor and the human healer, in tracing and curing our bodily ills. The prospects there are enormous—from the cure of cancer to the purchase from the chemist of a harmless, temporarily radio-active "pack" to cure warts or ringworm. And—as we suggested in a much earlier chapter—something even more wonderful: perhaps all biological "mutations" are caused by cosmic or other similar rays, and perhaps therefore, one day, we shall be able to control the genes and chromosomes of species.

Finally, two theories arising directly out of the study of the atom, which profoundly affect our whole conception of the universe and the meaning of it. They are Max Planck's *Quantum Theory* and Albert Einstein's *First (or Special) Theory of Relativity*. They are neither of them as modern—1900 and 1905 respectively—nor so incomprehensible as one might think.

The Quantum Theory brings in the idea of *Discontinuity*. We have always thought of time as continuous: you can of course split up a second into something as small as a millionth; yet time, one would say, flows on continuously nevertheless from that one millionth to the next. The same surely with energy. The heat-energy of something getting gradually hotter for instance: however minutely you divide it the increase is continuous. But the Quantum Theory says No! Take the emission of light, caused as we know by movements within the atom. Those movements, it is believed, are actual changes in the orbits of the electrons—an electron switches to a smaller orbit, and light and energy are sent out. Now the Theory says that this energy is sent out in small "packets" or *quanta*, when and only when there is this switch of orbit, and that it can only be sent out in that way. You simply cannot have half a packet. Energy is *not* continuous.

Nor is time. For here is enumerated the difficult idea that those electrons change their orbit in *no time at all*. . . .

Time also comes into the First Theory of Relativity. So does the speed of light.

Think first of relative speeds in ordinary everyday occurrences. If you are in a train going at forty miles an hour and are overtaken by one at sixty miles per hour, then the second will seem to you to be travelling at twenty miles per hour. But now take the earth travelling through space, with light rays from the sun passing it at 186,000 miles a second. When we are travelling towards those rays we ought to be able to observe by accurate and delicate instruments that they are flashing by us more quickly than when we are travelling with them. But such a difference could never be observed, though it was known that the instruments were delicate and accurate enough.

Einstein came along and said, "*You never will!*"

The velocity of light, he said, was the *same* for any observer whatever his motion.

And that is so, not by some incomprehensible magic but because with your motion your measuring instruments themselves change. Distance and time, he said, are not absolute, but "relative" to the motion of the observer.

That is difficult. What it comes to is that Space and Time must not be thought of as two separate entities. Two different observers—on Mars and the Earth, if you like, or on two different stars—split space and time differently, depending on their motion. *Now* and *Here* have different meanings to them. The proper way to think of Space and Time is in fact of two complementary aspects of one entity called Space-Time. And in that Space-Time, and only in that, are things absolute and not relative. Two observers may disagree as to place and time of two events. But combine the two and they do agree, always.

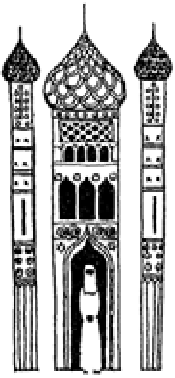
That is a hint at the First or Special Theory of Relativity. The General Theory of Relativity is too hard for this book. It propounds such things as that the Universe is expanding and that space is "as it were" curved. All one can say is: don't try to visualize that, it is impossible. To say that space "is" curved is nonsense; it is simply an analogy with a curved surface, to show that, like such a surface, it may appear unboundable to a wanderer on it but is in fact finite and not infinite.

As for Einstein's latest "Generalized Theory of Gravitation", with its two fundamental "Equations", that must remain entirely beyond us—it is a mistake to imagine that one can talk intelligently about these things without a great deal of knowledge. However, to help satisfy ourselves that we have an inkling of what he is driving at, perhaps this will help. Einstein is said to be trying to synthesize the Wave-and-Field-of-Force theory of the Universe with the Particle theory and so to achieve a definition of ultimate reality. . . .

One fact from all this at least should be absorbed, that the speed of light is a limiting factor. Nothing can exceed that speed, for as it approached it its mass increases—and to exceed it its mass would have to be infinite.

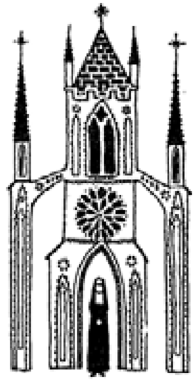
The modern picture of the Universe is in fact a very different one from the nineteenth century's: mass and energy interchangeable; mass changing with velocity; gravitation a "property" and not a "force"; time and space relative aspects of a "four-dimensional continuum" called Space-Time. One more thing even comes into the melting-pot: probability. One always imagined that the laws of physics were absolute and dependable. Not so however in such things as that switching of electrons from one orbit to another, or the disintegration of any particular atom in self-disintegrating radium. What will happen there, so far as we can understand at present, is completely unpredictable, quite arbitrary. And where do we go from there? It is for the philosopher rather than the scientist to tell us. . . .

BOOKS: For an introduction to atomic structure, and so to electricity, try the chapter on Chemistry by J. G. Pilley in the previously mentioned *Outline for Boys and Girls and Their Parents*, and then go on to Mr. Pilley's *Electricity* (Clarendon Science Series). Parts of *Marvels of Modern Physics*, by Joseph McCabe (Watts, 1935), or *Science, A New Outline*, by J. W. N. Sullivan (Nelson), will help. The best short book on "splitting the atom" is *Science News No. 2* in the *Penguin* series, while an excellent "popular" introduction to the study of atomic energy is Chapman Pincher's *Into the Atomic Age* (Hutchinson). *Relativity and Gravitation*, edited by J. M. Bird, contains the combined wisdom of the prize-winner and runners-up of a five-thousand-dollar competition for the best popular exposition of Einstein's theories; or if you prefer—and have some Mathematics at your disposal—you can go to the prize-winning book itself, *An Introduction to the Theory of Relativity*, by L. Bolton (Methuen).



CHAPTER XXII

MAN STRUGGLES TOWARDS WISDOM



(Touching on Philosophy, Logic, Ethics, Semantics, Politics, History, and Religion)

BEING wise is quite obviously not merely a matter of being full of knowledge. It is, rather, a matter of making good use of one's knowledge. It is a matter of thinking with a clear and a disciplined mind—a tolerant and a humanitarian mind too.

If it is true that the atomic age has launched us on a grim race between the attaining of wisdom and the descent into catastrophe, then the subjects of this chapter are indeed important.

We can do little more than introduce them; sometimes, even, it will be a warning off from a premature and too facile plunge into difficulties. It is, one might say, a chapter of *Outlooks* and *Values.*

Take Philosophy first. There are some very wrong ideas going about as to what is philosophy and what a philosopher. Of the latter? —somebody with a beard who is frightfully wise but who talks quite incomprehensibly: that is a not altogether ridiculous exaggeration of the popular conception.

The Greek word Philosophy means simply Love of Wisdom. A useful definition would be: the pursuit of knowledge in order to understand ultimate reality. Philosophy seeks to understand the nature and purpose and meaning of Man and his Universe.

Now Philosophy is a very old subject. It has been going on for two and a half thousand years; it has, we might say, been chewed over for two and a half thousand years. That is the danger, there has been rather too much chewing. Men love to use words, and rightly so. But not all words are wisdom, it is easier to rehash somebody else's thoughts than to be original; and we know from our history that the Greeks (who did more than any other people to found Philosophy) suffered particularly from having their wisdom chewed and chewed over right through the Dark Ages and up to the Renaissance. Aristotle suffered most in that way; so much so indeed that his book *Metaphysics* (which simply means that he wrote it *after* his book on Physics) has given an alternative title to Philosophy, or at least a branch of Philosophy, and has also—which is the major point here—become synonymous sometimes with hair-splitting and mystical meaninglessness.

Indeed, we are going to make a categorical statement here, which is wide open to misunderstanding but which, we feel, needs to be made none the less. It is this: undoubtedly it is important that you should have a philosophy of your own; but it is equally important that until you are ready for them you should avoid all books which seek to give a history of Philosophy or a potted edition of what the philosophers throughout the ages have thought. And when you are ready—which will be when you have formed your own outlook and have a pretty good knowledge of the universe around you—you may never want to know what other people have *thought* that the sages of the past have thought, but will prefer to pick your particular sage (past or present) and read him in the original.

The great thing to realize is that the philosophic outlook must change as our knowledge of man and the universe changes. Does that mean that the philosopher must be a scientist? Hardly a practising scientist—his job is to see the wood and not the trees. But it does mean that he must have a wide knowledge of Science, particularly in present times when scientific knowledge increases so fast. The philosopher's job is to bring together or synthesize, to arrange and co-ordinate, to explain and to see the implications of, Science in its widest sense. We spoke at the end of the last chapter of the idea that within the atom nothing is absolutely predictable and suggested that it had a significance for philosophers. It has. Is Nature governed by iron laws, or isn't it? In particular, what bearing has this on the age-old dispute about Free Will and Determinism; is everything arranged beforehand or not? One other example of the bearing of knowledge on outlook will help to bring home this idea that Philosophy can only grope after the truth and will always be changing. It is that argument —cited as so absurd in the Astronomy chapter—against Galileo's discovery of moons to Jupiter: "they would be of no use to man and so they do not exist". We should not have laughed at that if we had lived in the sixteenth century—unless we were one of those very rare geniuses who can escape from their own time and see with the eyes of a later age. We should have lived then within a "geocentric" philosophy, which held that all creation was for the benefit, or otherwise, of the inhabitants of this globe, and we should have seen nothing foolish in the criticism. Not that it is impossible—and we must add this lest we have given a wrong impression—for the wise men of any age, whatever may have been the state of material knowledge at the time, to propound fundamental truths from their wisdom and what we may call their inspiration.

A trouble about Philosophy and the history of Philosophy is that we cannot avoid it altogether even if we want to. It is too much a part of Western scholarship and culture and tradition. The terms and definitions which it has used we shall always be meeting in our serious reading, and we shall be at a loss if we cannot appreciate their significance.

That there should be two fundamentally contrasting and irreconcilable philosophies, called the *materialistic* and the *spiritualistic*, is easily understood. Either one holds that all phenomena have a material, that is to say physical basis, including ourselves and our minds; or else one believes that the spiritual is the thing that really matters and that physical things are only secondary, there is soul and body, mind and matter, spirit and substance, always two different worlds. And that is the first "term" to remember. This idea of the continual separation of the immaterial and the material—a double world with the one reflecting the other—is called *Dualism*. In Philosophy that word has that particular meaning.

But now we get on to what many have held to be dangerous ground. Plato was the first there. He was a Dualist but he went further. He held that the immaterial was far the more important, and that the world we know is what might be called a pale and confused reflection of it. There were, he said, *Universals*. They were such things as Truth and Beauty. In fact everything had its Universal, or its *Ideal*. There was, in the imagination, an ideal everything—simple and perfect: an ideal apple for instance, the "idea" of apple if you like, something you could reflect upon and talk about—and the various real apples that one met, all different, were mere poor reflections of that beautiful and simple Idea. Hence *Idealism*—used in a philosophical, that is a technical, sense.

Now we come to the danger, and at the same time to two new terms. The danger is that if we treat the *name* of a thing as in some spiritual and mystical way more real than the thing itself we may let words become master of us instead of us the master of words. We may become muddle-headed, we may dogmatize. We shall say that "all Englishmen" or just "Englishmen" do so-and-so, when we really mean that most of them do and with many exceptions. Worse still, we shall create entities that do not really exist, merely by giving them names. France, we say, does this and that; the United States thinks so-and-so. . . . Now we come to our two new terms. A philosopher of Compiègne in France, Roscellinus by name and living about the time that we were being overrun by William the Conqueror, enunciated flatly: "Universalia sunt Nomina", or in other words, Plato's Universals, which he claims are the true realities, are *just names*. There followed a wrangle that may be said to have gone on ever since: between the *Realists* (a term meaning that these Universals or Ideas are the only *real*ity) and the *Nominalists* (who said virtually, what's in a *name*?). That wrangle was, and is, important. The Realists, one might say without too much of a stretch, are now the mystics, and the Nominalists are those who pride themselves in thinking scientifically and logically.*

Now *logical* thinking, though we may pride ourselves on being able to achieve it, is not easy. The great danger indeed is that we do so facilely pride ourselves on having logical minds—it is one of the dangers to which our chapter on Psychology has drawn attention by stressing how wayward and wilful and unpredictable that new science has shown the human mind to be.

Logic, in fact, we may claim to have covered, or at least largely to have side-tracked, by saying something of what it has to say, but in a different way—not only under Psychology but for instance at the end of our chapter on Mathematics. Again in fact: to think logically is of supreme importance, but to read a standard book on logic or the history of logic is more than anything else likely to confuse. Philosophy is old. Logic is worse; it is—unless injected with doses of new and original thought—senile.

That statement is no doubt unfair. But it is an intentional unfairness designed to ward off the over-zealous self-educator. Let us be content with a definition and a look at one or two of the technical terms of Logic—for like Philosophy it comes from the Greeks and its terms are part of our language and at least in themselves not dead.

Logic may be said to be the science of *directed* or reasoned thinking. It has been defined as "the systematic study of the general conditions of valid inference". That of course necessitates another definition; inference is "the process of deriving one judgement or proposition from another or others". A simpler definition of logic is perhaps

* It would not be too much of a stretch to compare all this to a much more modern philosophic revolt, that of Jean-Paul Sartre and the Existentialists. "Existence," say these gentlemen, "precedes Essence," or Facts come before Idea. In your philosophic wanderings never forget Man's evolutionary story and the fact of his very human Human Nature!

"a scientific account of the laws which regulate the passage in thought from one statement to another".

One can either argue or think, it is said, *a priori* or by *induction*, or on the other hand *a posteriori* or by *deduction*: which means, put as simply as possible, from effect to cause or from cause to effect. One might at first glance imagine that deduction would be the only sane and scientific way to think and argue. But that is not always so. Sometimes induction, from effect to cause, is the only way: think of trying to discover what the invisible electron is doing, of divining the possibilities of atomic energy from radium, and the properties of X-ray. Induction gives scope to intuition and inspiration. The scientist will check back by deduction where he can.

One last term from formal logic; it is often used, and a knowledge of its implications is useful. This is the *syllogism*.

Aristotle christened it. And this is how he defined it: "a discourse in which, certain things being stated, something other than what is stated follows of necessity from their being so". A simple example will help:

(1) Credulous people are easily deceived;
(2) Sailors are credulous;
Therefore (3) Sailors are easily deceived.

And *not*, you will appreciate:
All easily deceived people are sailors.

The formal logicians called those three statements Major Premise, Minor Premise, and Conclusion. You arrive at the Conclusion by "Exclusion of the Contradictory". You can't have contradiction. . . .

And then along came Hegel, a great German philosopher of the nineteenth century, and said loudly and roundly, "Nonsense!" Not only can you have contradiction, but you always will have contradiction. The formal logician's world is static, he said, hopelessly static. But the real world is not like that. It changes. It *is* conflict—the negative, as it were, warring with the positive, to produce a third thing, something else—and then starting all over again. For your three-cornered syllogism, Hegel said, I give you another trinity: *thesis*, *antithesis*, *synthesis*.

And the particular significance of *that*—to jump, as we must in this chapter, rather bewilderingly from one subject to another—is that Karl Marx, the founder of modern Communism, based his political philosophy very closely on this Hegelian substitute for the syllogism. He called it *Dialectic Materialism*.

Now that is a phrase which the Marxian is continually and in a superior manner throwing in the teeth of the non-Marxian, with the pretty clear insinuation that the latter doesn't even begin to understand it and is therefore not in a position to understand Marxism. Usually he is right. Dialectic means simply "logical disputation", or a *method* of testing truth by discussion—it has actually the same Greek root as our word "dialect", though obviously it has a different and derived meaning. The "dialectic" that Marx continually used was Hegel's substitute for the syllogism.

But Marx put it on a particular plane, a historical rather than a philosophic one. History, he said, is essentially a series of conflicts. Further, the things that really influence History are *material* things. They are economic. What people think, their ideas, are secondary. Any change in "powers of production", he said, gives rise to a corresponding set of economic relationships designed to further the use of those powers. These relationships in turn range men into economic classes. And it is between those classes of men that conflict arises—until there is obtained the Hegelian "synthesis" of a classless society.

Something like that is the Marxian idea: no one can expect a couple of books to be put into a sentence and justice to be done. Perhaps however that does make an otherwise incomprehensible phrase mean something.

The next great thing to realize about Karl Marx is that his theory has a great neatness and a very great deal of inevitability about it. One either takes it whole and unquestioningly or not at all—though that was doubtfully his intention. It has the aspect of a "law" of Nature: the class conflict *must* continue until it has resulted in the dictatorship of the proletariat and the classless society. It is just as definite as that the Survival of the Fittest must result in Evolution. There are those who point out unkindly that Marx lived at the same time as Darwin—and felt the need to produce as startling and definite a proposition. . . .

But quite obviously this book must try to avoid the taking of sides. Logic and Philosophy have led us on to Politics; and Politics is where one finds it very difficult not to take sides.

In fact, that is probably all that can usefully be said about politics: one should not take sides too violently.

Yet is that true, is it good advice? Surely if one always sees the other fellow's point of view one never gets anywhere. That also is true. Indeed one comes up against the fundamental dilemma of politics, and of much else: how to find the useful mean between the driving power of fanaticism and the sanity of the reasoned and philosophical attitude. It is at least something to appreciate the dilemma. And surely the way out, if anywhere, is—as we suggested in the very first chapter of this book—by education. If we are well informed, if we refuse to be stampeded by the cheap appeal to emotion, we can still have enthusiasms, and better enthusiasms at that.

Nor, with better education, will differences be so extreme, so bitterly and idiotically irreconcilable, as they are at present, just because the one side does not begin to see and has no intention of seeing what the other side believes or understands. At present there is a brick wall —or an iron curtain—between one set of people and another; there is lack of communication. Words apparently cannot bridge that gap or penetrate that wall; indeed they only make it wider or thicker.

Let us look at this idea for a few paragraphs: it is fulfilling the promise made in the chapter on English to come back to the science that is sometimes called Semantics.

Another and older word for it is Semasiology. *Semasia* is the Greek for meaning, and *Semantikos* for significant; and the two together give us an inkling of what this science is: an enquiry into the significance and meaning of words. We have just been saying that words seem often to fail signally to bridge the gap between minds. That is the subject of Semantics: *why aren't words a better means of communication?* For they certainly are not always very good. Words mean different things to different people. Words often seem to mean virtually nothing at all. (Of that the modern Semanticist accuses the ancient Philosopher and logician: spinning words until his reader, if not also himself, is dizzy.) Now why is all this?

It really goes back to the danger besetting the philosophic Realist, that of failing to remember that the word is not the real thing but the physical entity behind it. That indeed is what the practitioners of this science insist upon: *always think back to the thing referred to.* They call it the *referent*.

Now this business of "find the referent" is not easy. That is the great point: that it is not easy. We spoke in the chapter on English of the fact that communist and non-communist have a very different idea of what is meant by Democracy. What is the "referent" of Democracy? It is very difficult to define and to agree upon. But it can be agreed upon. What is not so easily recognized is that until people do agree, it is largely waste of breath talking about it, certainly waste of emotion to get dangerously worked up about it.

With this critical weapon in our hands we can do a lot of debunking. There are simple people who expect a simple answer to such questions as "Is environment more important than heredity?" The proper answer is that as it stands the question is practically meaningless. It is meaningless unless and until we can find a series of things in the real world that can properly be summarized by those two words and we can then agree upon our findings.

Words in fact, and as we have often said in this book, are wonderful things but terribly prone to misuse by the uneducated.

And—to shift to our next point or subject—the *real* prerequisite of political intelligence and nous is surely a knowledge of history: if we know little of Man's past we can lay little claim to a say in his future.

In our chapters on History we decided upon a survey of the whole world-story as being the first essential; but that, pretty obviously, does not mean that other sorts of history should be ignored. Achieve the wide view; then that wide view lends enchantment—not to mention better understanding—to the smaller. The trouble with learning history at school is the trouble with so much else: one does not *know enough* to appreciate it. There is no cure except to start again when older.

There is much talk nowadays, especially in the examination world, of Current Affairs. If one desires to be knowledgeable in Current Affairs one reads, presumably, the newspaper, or rather that portion of it—a very small portion in a popular paper—that deals with events of any real significance for the fate and future of mankind. But if one has no background, no conception of the story up to the *now* that one is reading about, one is largely wasting one's time. Newspapers and magazines are very skilful and efficient productions. Nevertheless, if the mass of people divided their reading of such by four, and then spent a quarter of that time in reading something else—not necessarily "heavier"—we should undoubtedly be a better educated and more understanding nation. The two biggest practical needs for most of us are a re-reading of our own country's history—we shall probably be amazed at how interesting it is when it has ceased to be "part of homework"—and to learn something of European history, particularly of the last hundred years.

Do not believe that "history repeats itself"; or at least take it as a gross overstatement. It is truer to say that human nature will indeed be likely to react similarly in similar circumstances—but that circumstances are never as similar as all that. Take war for instance: must there always be war? Certainly it saddens and bewilders us to read how much of war there has been throughout history. But even there the wide and long view helps: the simple hunter, for instance, through all his long centuries, warred in all probability hardly at all. To assume that war must continue because of the innate combativeness of Man is to fail to appreciate the changed circumstances of the day. Modern war gives little scope for the combativeness of Man—only rather to his vulnerability to mass slaughter. Which means of course that war, as well as being no longer an inherent necessity, is paramountly a thing to be itself combated and prevented at almost any cost.

At *almost* any cost? Or at *all* costs? We have arrived at ethics, the philosophy of morals and of right and wrong.

Ethics is another subject with a very long history behind it. And once again we assert, at the risk of being misunderstood, that here is a subject best left alone unless one intends to study deeply. Just occasionally Pope is still right: a little learning may be harmful and intoxicating. To have moral standards is of course of paramount importance; the real danger is from the shallow judgement, cynical and jejune (that damning adjective!), of the cocksure student with a smattering.

For there has been much talk during the last few decades in the vein that morals are merely relative and expedient. If a primitive tribe living a hard life could only retain a grip of existence by keeping its numbers down and its health and strength up, then practices of infanticide and the like, it is held on this theory, are not immoral but moral. In certain circumstances polygamy works well and is justified—and the righteous indignation of the upright Christian at the Mormon or Moslem is pure narrowness of outlook.

Now up to a point that is true—and salutary to think upon. But surely up to a point only. Surely Man is endowed, or at least by becoming civilized has endowed himself, with an inherent and to-be-trusted sense of what is right and what is wrong. Read this from a broadcast by a great and fine scholar, Gilbert Murray:

> "The moral sense has always seemed to me very like one's sense of beauty. I don't know in the least what absolute right is or what absolute beauty is, but, when I am faced with a difficult decision I do look as it were at one course and see at once that it is ugly, dirty, repulsive, not the sort of thing I like; another, if painful, looks right or good. One feels disgust at the thought that one might be dishonest or mean or cruel, and a longing to be quite different. The Greeks used the same word 'ugly' for an ugly sight or a disgraceful action, the same word 'beautiful' for a beautiful sight and a right or noble action."

And then again:

> "In a moral education there will be a prolonged tug-of-war as it were between egoism, care for oneself, and altruism, care for others. This tug-of-war leads to a mixture of opposite emotions in a

man towards his society—ambivalence as the psychologists call it: love and hate, obedience and rebellion, a wish to please and a wish to defy. . . . This ambivalence, or tug-of-war, lasts in one form or another throughout life, and I suspect that the great problem of conduct is to transform this conflict into a harmony: not into absolute uniformity, of course, the social code would never move forward or reach a deeper understanding of its duties without constant criticism from individuals, with freedom for rebellion and reconciliation."

We begin to appreciate perhaps that to be able to discourse wisely upon ethics one needs not to be able to split hairs or to know what others in the past have written about it, so much as to have a knowledge of psychology and the like, coupled very definitely with a fund of common sense, humility and common kindliness.

One more idea we might perhaps usefully consider. Are human actions to be judged good or bad purely by their results, as the school of philosophers called the Epicureans* thought; or is it rather as the Stoics held, that actions are inherently right or wrong? It is something the same if we say: is it *ends* that matter, or *means*? We shall each have our own answer to that, and it is well that we should indeed formulate an answer for ourselves. Remember this, however: it is very easy to *persuade* oneself that the means one wishes to adopt will be justified by the end one expects to achieve. As we learnt in our chapter on Law, expediency is a very dangerous, and can be a very immoral, master.

We come, last and at last, to Religion. How dangerous? But we shall not achieve much by timidity.

Should one know something of the other religions of the world besides one's own? Surely! And surely, too, one must face up to the fact that ninety-nine of every hundred of us acquire our religion by the mere accident of being born into a particular time and nation and culture. How, or indeed why, should it be otherwise? Religion, whatever it may be—this we must learn to appreciate—is the great binding force of communities and cultures.

If we face up to that, we must then face up to the necessity of a very wide tolerance. Yet how wide? Not at any rate until it levels down into mere apathy: it is the old problem again of finding a mean between enthusiasm, plus possible excess, and an outlook so judicial and philosophic that it kills all enthusiasm and becomes dead negation.

We have already learnt quite appreciably about religion—primitive religion and the history of religion—in the chapter on Anthropology

* Named after the Greek philosopher Epicurus (*d.* 270 B.C.).

and in other odd references. It is a surprising picture we get, and perhaps rather a worrying one to us when we come to it for the first time. How deeply is religion mixed with superstition! But do not jump from this to the false conclusion that all religion is silly superstition; that is a very different thing from having *grown out* of it. (Science for that matter grew mostly out of silly superstitions too.) Much of Christian belief can be traced back to pre-Christian superstitions; but mostly this means that Christianity took the old beliefs, often quite consciously and of set purpose, and did its best to sublimate them.

A warning is necessary here. Many books on religion may give the inexpert reader a feeling of critical dislike, of disillusionment and bewilderment, because, in tracing the growth of the various religions, so much is said of myth and magic and superstition with apparently so complete an acceptance and lack of criticism.

This one must discount, taking it that the expert has grown too used to his subject to appreciate such a reaction on the part of his simple reader. True religion is not superstition.

What is it then? Perhaps to tie oneself down to a strict definition is not even very helpful. Religion is obviously more than believing in God or Gods. Then again, much of past and even present religion is a matter of sanctions, of threat of punishment or promise of reward in a future life, in an effort to act as the moral policeman. That in its narrow sense is not what a civilized person understands by religion—though this is not to say that his fundamental beliefs will not influence his conduct. Religion is, rather, the belief in some external Power and Purpose, above and beyond the mere material aspect of life.

Does Science kill religion and the necessity for religion? Of course not. It kills a great deal of superstition, and a great many ancient naive beliefs too—though do not let us risk throwing the baby away with the bathwater and forget that there is a good deal which is both poetic and kindly in those beliefs. Science must remain humble and realize its limitations, which are strictly material. Life—the stream of our individual lives—must surely be an emanation of, a representation of, something wider and deeper that lies behind it all, something spiritual and not material. We may call it God, or Brahma, or the Life Force, or what we will. . . .

The world's great religions have sought to understand that. Besides Christianity—about which it must be assumed the reader of this book will know a good deal!—the greatest religions are Hinduism (or Brahmanism), Buddhism, and Mohammedanism. Let us look very briefly at those three.

Hinduism is amorphous and the least easy to define, It is the oldest, and so perhaps the easiest to denigrate. For, being old, it contains a vast amount of pure primitive superstition—that unashamed fertility worship that uses phallic symbols and the like with a crudity which we can hardly believe to be as sublimated as the defenders of Hinduism would assure us. It suffers more than any other religion perhaps from being one thing to the intelligent and civilized and another and a lower thing to the uneducated masses.

The Hindu sacred writings are called the Vedas, written about the same time as the Homeric legends and in a language, Sanskrit, as dead as Homeric Greek. There is a trinity of great Gods, Brahma, Vishnu and Siva. Brahma is the Creator—impersonal and so not popularly worshipped. Vishnu is on the whole the kind and gentle god. He has had many incarnations or visits to this earth ("avatars"—a word that, like many others from alien religions, has crept into our language), one of the most popular being as Krishna, a jovial and amorous god. Siva is mostly a fierce and terrible god, and the bull, emblem of fertility, is sacred to him.

If we describe all that without comment or criticism we fall into the misleading error of which we have accused the experts. To study the "pantheon" of Hindu gods is a job for the mythologist or the reformer or the artist—the artist because so much of Indian art, to Western eyes sometimes beautiful but often disturbing and even revolting, is concerned with the Gods. The important thing about Hinduism is its central belief, the belief in the Transmigration of Souls.

The Soul, it is held, is eternal; it can only *act* and *will* when housed in bodily form. Yet to be so housed is to be evocative of misery and evil. Further, "as ye sow so shall ye reap" : on the amount of evil done in one incarnation depends the form of the next, great evil resulting in a tour in some lowly and disgusting insect, perhaps, or even a sojourn in some Hell. The opposite also holds good. This at least gives a logical explanation to the injustices of this world, apparently ill-deserved bad luck being the penalty of evil done in a previous *karma*, or life-action of the past, and vice versa. It is also the direct cause of the Hindu's great respect for life in all its forms and his unwillingness to kill even the lowliest.

Buddhism has much in common with Hinduism. For the Buddha was himself an Indian and lived when the Hindu religion was already established.

Gautama Buddha, or Gautama the Enlightened One, lived in the sixth century B.C., and there is no reason to suppose that he was not a historic person. He lived in that century of magnificent religious and moral advance to which we referred in our second History chapter

—he was a contemporary of some of the greatest Hebrew prophets and of the Chinese teachers of gentlemanliness and gentleness respectively, Confucius and Lao Tse. Gautama's story—the story of a young pampered Prince giving up all to take to the life of hardship and contemplation—is a story both romantic and beautiful.

The Buddhist's view of this earthly life is even sadder and more disillusioned than the Brahman. These are the "four noble Truths" as told by Gautama to his disciples:

> "Now this, O monks, is the noble truth of pain: birth is painful, old age is painful, sickness is painful, death is painful, sorrow, lamentation, dejection, and despair are painful. Contact with unpleasant things is painful, not getting what one wishes is painful.
>
> "Now this, O monks, is the noble truth of the *cause of pain*: that craving which leads to rebirth, combined with pleasure and lust, finding pleasure here and there, namely the craving for passion, the craving for existence, the craving for non-existence.
>
> "Now this, O monks, is the noble truth of the *cessation of pain*, the cessation without a remainder of that craving, abandonment, forsaking, release, non-attachment.
>
> "Now this, O monks, is the noble truth of the *way that leads to the cessation of pain*: this is the noble Eightfold Path. . . ."

And:

> "This is the noble Eightfold Path, namely, right views, right intention, right speech, right action, right livelihood, right effort, right mindfulness, right concentration."

Buddhism also believes in the *Karma* and a long cycle of earthly incarnations for the soul. This cycle will go on until that power which impels to rebirth—the power that is a carnal craving and desire for existence—is finally extinguished. Then comes *Nirvana*, which is the aim of all right-thinking men. And Nirvana is not mere nothingness, mere non-existence, but a blessed sloughing off of all material desires and senses such as only the most holy Buddhist can begin to understand. Buddhism is sometimes called a religion without a god. It is certainly, in its higher and purer reaches, a religion with a fine moral code. It also shares with Hinduism a reputation for tolerance and for refraining from militant proselytizing.

Not so Mohammedanism, which has sought throughout its history to convert, if necessary at the point of the sword. The rise of the Arabs to power in the seventh and eighth centuries A.D., under the impetus of their new religion, is undoubtedly one of the wonders of history. We have all read something of it—if nowhere else, in our children's stories of the Crusades. It brought many words into our language, and not least significant was "Infidel"—the dog better dead who would not believe in Allah the one God and in Mohammed the last and greatest of his prophets. Not so, however, the "Believer", whose reward—most certain of all if he died fighting for his faith—was an extremely material Paradise. In that paradise a specially created race of angelic *houris* ministered to the comforts and the needs of men. What bliss women were to find in Paradise or whether indeed they ever got there was not so clear to the fanatical followers of Mohammed.

That no doubt is an unfair and crude comment on the Moslem religion. Its standards of conduct as laid down in the Koran are high and hard. It is however probably true to say that it is the simplest and the least subtle and spiritual of the great religions; and that its fierce intolerance coupled with its blind fatalistic belief in Kismet (literally Obedience to the Will of Allah) has made it historically a dangerous religion.

"Dangerous" certainly does not describe the two religions of China besides Buddhism: Taoism and Confucianism. (The danger is rather that the Chinese do not follow the precepts of their gentle philosophers.) Indeed these two are hardly religions at all, but rather codes of conduct. For more about them, and about these and other religions that we have and have not sketched, the reader must go to such a book as is recommended at the end of this chapter.

But finally, remember this about the religions of the past, that they have always been the *binding force* of the culture in which they thrived—even from the time when religion amounted to little more than "thou shalt not disturb the luck of the tribe!" What we need to learn is that that may still hold true in a much less simple world.

Or is simple faith no longer possible? Must we depend solely upon reason? If so, then we have a long way to go, for there is little evidence that Man has behaved reasonably of late. In the words—pessimistic words—of a book which will be recommended shortly: "Our hope, if hope remains, is to go back to the orthodox religions or to formulate an entirely rational philosophy." There lies one of the fundamental problems facing the human race at the present time. . . .

Problems facing the human race. Human problems. *That* is what we really educate ourselves for, or ought to educate ourselves for: to be able to solve, with wisdom, the problems of mankind.

Do not let us be sententious about this, priggish about it. We are not likely, any of us, to be able to solve these problems unaided.

But it will be a poor show if we have no ideas on the subject, or if our ideas are hopelessly wrong from the start.

And that may well be, for human nature is not simple. And if people do not take the trouble to learn about their own nature, how can they hope to legislate for their own future or procure their own happiness?

We are back, at the end of this book, full circle to the beginning. "The proper study of mankind is Man"—and the proper way to make that study is to take advantage not only of the great inheritance of the past—the Western Tradition—but of all the new knowledge, biological, psychological, historical and the rest, that the last few generations of learned men and women have given us.

Man in his home the World. Man in his Environment, seeking to control it. Man in Society, seeking a satisfactory way of life. Those are the ways in which to think; that is the framework in which to view the world's problems. Do that, and surely we cannot be entirely wrong. Fail to do it, and we do not even begin to be right.

What is Man's nature *really* like? That the social reformer must continually ask himself—lest his reforms do more harm than good. It is not an easy question to answer. To help people to answer it might be said to be the highest aim of this book: learn to appreciate what Man's world is like and what he has so far achieved in it, and we can have some idea of the sort of environment in which human nature really flourishes and what are its potentialities in such favourable surroundings. Understanding ourselves, it might be said, is the beginning of wisdom. . . .

Is Man really fitted to be a machine-minder and a factory hand? Does he really enjoy being pampered and entertained, or does he prefer to do, to create, to express himself? Must he not have always something to cling to which will afford him a feeling of self-respect and achievement? Can he only thrive and display his finer nature when his environment is hard and recalcitrant? Is Man's a kindly nature essentially, and if it is how can that kindliness be brought forth? Can he ever live in society and in amity with his neighbours? And finally, if that is possible, must the form of society which seems best suited to him be imposed on him?—or will that very coercion defeat its own object and must, rather, men find their own salvation and be afforded individual freedom of thought and action wherewith to do it?

Those and many more like them are the real problems of society. And to guide us towards wisdom in solving them there stands waiting all the knowledge of the ancients and of the moderns, all the arts and all the sciences, all the grace and inspiration that is contained in books.

Yet it is not only in books that we find the answers. Let that, paradoxically, be the last word of this book which is largely about books and will end its last chapter as usual with a list of them.

Everyone must surely beware of becoming a bookish prig. How wrong, how narrow are those who can only learn from the printed word! Yet there are people who never seem to believe anything unless they have read it, who seem almost wilfully to have atrophied their other perceptions. How right, too, are people sometimes when they speak with suspicion and in derogatory terms of "the Intellectuals" and the "clever"! For what are they really saying? They are accusing those they rail at of lack of true understanding, of a cranky wrong-headedness, of having dried up within themselves the milk of human kindness—in a word, of *lacking humanity*.

Let that, then, be the very last word. However practical your desire for knowledge, always believe that the fundamental basis of learning is: to study humanity, and to practise it.

BOOKS: The book from which we last quoted is *Man and the Atom* (Michael Joseph, 1947), by C. E. Vulliamy. This, besides some physics of the atom and a review of the tremendous problems our recent discoveries have raised, contains a short history of philosophy which, if it may seem prejudiced at times, does not in the least become hair-splitting or obscure. A book which gives a philosophic interpretation of modern science is C. E. M. Joad's *Guide to Modern Thought* (Gollancz). You will find there, amongst other things, a reasoned and reasonable explanation of psychic phenomena and a good antidote to the naive belief that these have necessarily anything to do with a personal "after life".

The greatest modern English philosophers are probably Bertrand Russell and A. N. Whitehead.

Karl Marx there is perhaps no more reason to read in the original than, for instance, Charles Darwin—you will certainly find him harder going. A sympathetic exposition is *What Marx Really Meant*, by G. D. H. Cole (Gollancz), and a more critical one is *Communism and Man*, by F. J. Sheed (Sheed & Ward).

For Semantics go to *The Tyranny of Words*, by the homely and cheerful American popularizer, Stuard Chase (Methuen). A harder and deeper book is *The Meaning of Meaning*, by C. K. Ogden (the inventor of Basic English) and I. A. Richards (Kegan Paul.

As for History, the choice is of course tremendous. For the last century in Europe and in England, go to William Gerhardi or Arthur Bryant. One should not read such a book as *English Social History*

(Longmans), by C. M. Trevelyan, until one has a decent background of the factual history. *A History of England*, by André Maurois, is short and easily read, and has perhaps the advantage of an impartial observer, since it is written by a Frenchman.

A. L. Rowse's *The Use of History* (*Teach Yourself History Library, 1946*) will give you some very practical reasons why you should read history and a detailed bibliography from which you can take your choice.

For a description and appraisal of the world's beliefs, ancient and less ancient, and including Christianity, there is *Ethics of the Great Religions*, by E. Royston Pike (Watts). Part of Hutchinson's *University Library* is devoted to a series of books on the world's religions.

APPENDIX

SOME WORDS OF GREEK DERIVATION

HERE are some of the most common Greek words, used in scientific, semi-scientific, or everyday English.

A similar list could of course be given of Latin derivations; but there one would not know where to stop and most of them, in any case, are better known.

Sometimes a word is duplicated under both of the Greek words from which it comes—this to give an idea of how many of our Greek derivatives are a combination of two (or even more) words and what an almost infinite variety this gives us.

A definition of a word is only given when it is not obvious or well known.

A, AN = not

Anarchy, no rule.
Anonymous, no name.
Agnostic, one who says "I don't know!" or rather, "You *can't* know!"
Amorphous, no shape.
Atheist, no God.

AGO = I lead

Demagogue, leader (and swayer) of the crowd.

AMPHI = both, on both sides of

Amphibian, living in both elements, air and water..
Amphitheatre, with seats rising on both sides, or around.

ANTHOS = a flower

Chrysanthemum, a golden flower.
Polyanthus, many-flowered.

ANTHROPOS = Man

Misanthrope, one who hates his fellow men.
Philanthropist, one who loves his fellow men.
Anthropophagy, man-eating, or cannibalism.

AUTOS = self

Automaton, acting by itself.
Automobile, moving by itself.

BALLO = I throw

Hyperbole, "excessive throw", or exaggeration.
Ballistics, science of projectiles.

BIBLOS = a book

Bibliophile, a book lover.
The Bible.

BIOS = Life

Biology; *Biography*; *Amphibian*.

CHROMA = colour

Panchromatic, all coloured (or responsive to all colours).

CHRONOS = time

Synchronize, to put "together" in time.

DEMOS = the people

Endemic (disease), found regularly amongst certain peoples.
Epidemic (disease), found at a special time amongst certain peoples.
Democracy (definition to taste).

DOXA = an opinion

Orthodox, having correct opinions.
Heterodox, having different opinions.

DROMOS = a course

Hippodrome, horse racecourse.

DUNAMIS = power

Hydro-dynamics, science of water power.
Dynamo, (electric) power-producer.

EPI = upon, in addition to

Epicycle, one circle on the edge of another.
Epilogue, spoken in addition to, or last.

EU = well

Eupeptic, digesting well.
Euphony, good sound, or harmony.

GAMOS = marriage

Misogamist, marriage hater.
Polygamy, having many wives.

GE = the Earth

Apogee, most distant point (of sun, etc.) from the earth; highest point.
Geography.

GENOS = a kind

Homogeneous, of the same kind.
Heterogeneous, of different kinds.

GLOTTA = a tongue

Polyglot, of many tongues or nations.

GRAPHO = I write

Telegraph, writing from afar.
Geography; *Biography*; *Autograph*.

GUNE = a woman

Gynaecologist, a doctor who specializes in women (and, in particular, childbirth).
Misogynist, woman hater.

HELIOS = the sun

Heliolithic, the Stone Age culture that worshipped the sun.
Heliotrope, the flower which turns to the sun.

HUPER = above

Hyper-sensitive, etc.

HUPO = below

Hypodermic, introduced underneath the skin.

ICHTHUS = a fish

Ichthyosaurus, fish-like reptile.
Ichthyophage, fish-eater.

ISOS = equal

Isosceles, having equal "legs".
Isotherm, line joining places of equal heat.

KAKOS = bad

Cacaphony, bad sound—discord.

KARDIA = the heart

Cardiac trouble, heart trouble.

KEPHALE = head

Cephalopod, "foot-in-head" animal—e.g. octopus.
Brachycephalic, short-headed.

KOSMOS = the Universe as an ordered whole; order; beauty

Cosmopolitan, a citizen of the world.
Macrocosm ⎫ of the big ⎫ world.
Microcosm ⎭ little ⎭
Cosmetics.

KRATOS = power

Autocrat; *Democracy*.

KRITES = a judge

Hypercritical.

KRUPTO = I hide

A crypt; *Cryptic*.

KUKLOS = a circle

Bicycle; *Cyclometer*.
Cyclops, giant with one circular eye.

LITHOS = a stone

Heliolithic.
Monolith, (a prehistoric monument of) a single stone.
Lithography.
Paleolithic, Early Stone Age.

LOGOS = a word or discourse

Biology; Logarithm; Epilogue.

MEGAS, MEGALE = great

Megaphone.
Megalomaniac, someone who imagines he is great.
Megalithic (a monument), of giant stones.

METRON = a measure

Geometry, etc.

MISEO = I hate

Misanthrope, a hater of his fellow men.
Misogynist, a woman hater.
Misogamist, a marriage hater.

MNEME = memory

Mnemonics, aids to memory (the "m" is mute).

MONOS = one

Monolith; Monastery; Monopoly.

MORPHE = shape

Amorphous; Anthropomorphous.

NAUS = a ship

Nausea, sea-sickness.

NEOS = new

Neolithic, New Stone Age.

ONOMA = a name

Anonymous, with no name.
Synonymous, having the same name.

OXUS = sharp, acid

Oxygen, a generator of acids.

PAS, PANTOS = all

Panacea, a remedy for everything.
Pantheon (a temple), to all the Gods.
Pantomime, mimicking everything.

PATHOS = feeling, suffering

Pathos; Pathetic.
Pathology, the science of (suffering or) disease.

PHAGO = I eat

Xylophagous, feeding on wood.

PHILEO = I love

Philadelphia, (a place named after) brotherly love.
Philanthropy.
Theophilus, a lover of God.

PHONE = sound

Telephone, sound from afar.
Euphony.

PHOS, PHOTOS = light

Phosphorous; Photography.

PHREN = the mind

Phrenetic, frantic or mad.
Phrenology.

PHUTON = a plant

Phytography, descriptive botany.
Zoöphyte, plant-like animal (three syllables).

PLASSO = I form

Protoplasm, the first form of life.

POLIS = a city

Heliopolis; Cosmopolitan.

POLUS = many

Polyanthus.
Polygon, having many angles.
Polytechnic, (a place where is taught) many arts or sciences.

POTAMOS = a river

Hippopotamus, a river horse.

POUS, PODOS = a foot

Arthropod; Cephalopod.

PROTOS = first

Prototype, original model.
Protoplasm.

PSUCHE = the soul

Metempsychosis, the transmigration of souls.
Psychology.

PTERON = a wing

Pterodactyl, wing-fingered.
Coleoptera, sheath-winged (beetles).
Hymenoptera, membrane-winged (bees).
Lepidoptera, scaly-winged (butterflies and moths).

PUR = fire

Pyrites, fire-stones—i.e. flints.
Pyrotechnics, fireworks.

RHEO = I flow

RHEUMA = a stream

Rheum, watery secretion.
Rheumatism; Catarrh.

SAUROS = lizard

Dinosaurs, the (prehistoric) "terrible lizards".

SKOPEO = I see

Microscope, seeing small.
Telescope, seeing far.
Horoscope, seeing the stars at *hour* of birth.

SOPHOS = wise

Philosophy.

STROPHE = a turning

Strophe, a measure in verse or dancing.
Catastrophe, final turning or tragic dénouement in a play.

TECHNE = art or skill

Technical; Polytechnic.

THEOS = God

Theology; Theocracy; Atheist.

THER = wild beast

Dinothere (prehistoric), "terrible beast". (Most of the scientific names for the extinct mammals—as opposed to saurians or reptiles—end in *there.*)

TOME = a section or cutting

Atom, can't be divided or cut (!).
Anatomy, dissection.
Epitome, an abridgement or condensed account.

TOPOS, a place

Topography, mapping.
Utopia (*ou-topos*, no place—an imaginary place).

ZOÖN = an animal

Zoöphyte, animal-plant.
Zoology; Zoo.

THE END

INDEX

(NOTE.—The subjects mentioned in the Chapter sub-titles are not indexed, even when referred to in other chapters. The Definitions in architecture, art, economics and music are not indexed separately. Similarly the bibliographies at the ends of the chapters are not indexed. When a subject is referred to on several more or less consecutive pages it is indexed as "et seq.".

A

Abelard, 93
Abraham, 93
Accidence, 147
Acid, an, 21
Acoustics, 33
Adler, Alfred, 136
Aeschylus, 176
Air, 23, 32, 53, 252
Akhnaton, 12, 37, 246
Alaric, 93
Alchemy, 104
Alexander, 26, 93, 99
Alfred, 93
Algae, 74
Algebra, 224
Alice (*in Wonderland*), 18
Allah, 293
Allotrope, 21
Alphabet, 90
Amoeba, 67
Amos, 93
Anarchy, 257
Animal Kingdom, the, 67
Animism, 131
Arabs, the, 104, 292
Archimedes, 26, 93
Arithmetic, 224
Aristocracy, 257
Aristotle, 12, 98, 181, 257
Arthropod, 68
Arthur, 93
Aryans, 95, 99, 101
Asoka, 93
Astrology, 43
Athens, 100, 206
Atlantic, the, 103, 105
Atom, the, 16, 18, 19, 268, 275
Aton, 37
Attila, 102
Augustine, 93
Averages, 234
Aztecs, 94, 252

B

Bach, 180, 184 (note)
Back to Methuselah (G. B. Shaw), 58
Bacon, Roger, 93
Bacteria, 74, 113
Balzac, 169
Banks, 242
Baroque, 213
Barrister, A, 261
Baryspere, the, 46
Beaker People, 199
Becquerel, 274
Bede, 93
Beethoven, 93, 180, 185
Bergman, Ingrid, 175
Beveridge, Lord, 244
Bible, the, 75, 153, 255
Binary stars, 40
Biological categories, 68
Birds, 61
Birth of the Planets, 40
Blake, William, 161, 194, 214
Blood, the, 110 et seq.
Body-Mind, 129
Boyle, Robert, 31
Brahma, 12, 291
Brain, 83, 125, 255, 273
Brave New World (Aldous Huxley), 128
British Museum, 198
Bronze Age, the, 87 et seq.
Brownian Movement, 30
Buddha, 93, 99, 291
Bunsen, 42

Burne-Jones, 12, 204
Burns, Robert, 160
Byzantium, 102, 103

C

Cabinet, the, 259
Calculating machine, 273
Calculus, the, 232
Calories, 114
Canaletto, 196
Canute, 93
Capillaries, 112
Carbo-hydrates, 114
Carbon, 22
Carthage, 99
Catalyst, 22
Cathode ray, 272
Catholic Church, 103
Cave man, 85, 250
Caxton, 93, 153
Cell, the, 58, 112, 117
Celtic, 97
Cerebellum, 121, 125
Cerebrum, 125
Cervantes, 169
Chance, theory of, 235
Charlemagne, 93
Chaucer, 93, 168
Chesterton, G. K., 144, 161, 166
China, 99, 101, 104, 194
Chlorophyll, 72, 110
Christianity, 100, 105, 113, 131, 211, 290
Chromosomes, 65, 118, 277
Churchill, 93
Civil Law, 260
Civil servant, 89, 258
Classical Ages and Styles, 91, 212 et seq.
Classification (Zoological), 65, 66
Cleopatra, 93
Climate, 51, 251
Clothes, 251
Commerce, 251
Coke, T. W., 250
Colour, 34, 204
Columbus, 93
Common Law, 260
Communism, 131, 284
Complex, the, 135
Compounds, 16
Conditioned reflex, 126
Confucius, 93, 99, 293
Conrad, 152, 166
Constable, 196
Constantine, 93
Cook, Captain, 256
Copernicus, 12, 41
Corbusier, 215 (note)
Cortes, 12, 94
Cortex, the, 123
Cotswolds, the, 216
Councils, County, etc., 263 et seq.
Counterpoint, 183
Courts of Law, 261
Criminal Law, 260
Croesus, 96
Crookes, Sir Wm., 274
Cuneiform, 90
Curie, Mme., 274
Current affairs, 287
Custom, 256
Cycle of life, 75
Cyrus, 93

D

Dalton, John, 16
Dance, the, 133, 176
Dante, 93
Darius, 93
Dark Ages, 90, 103, 211, 281
Darwin, 41, 63, 76, 93, 136, 163, 180
David, 28, 93
Decimal system, 27, 221, 223
Definitions, architecture, 208
——, art, 204
——, economics, 247
——, music, 186
De la Mare, Walter, 161
Demand and supply, 241
Democracy, 98, 145, 257
Descant, 183
Descartes, 230
Design, 200
Determinism, 281
Dialectics, 284
Dickens, 12, 172
Digestion, 109
Diminishing returns, 241
Dinosaurs, 60
Discontinuity, 277
Dollars, 246

Dostoevsky, 169
Doyle, Sir A. Conan, 167
Drake, 251
Dreams, 134, 135
Dualism, 124, 282
Dumas, 169
Dust bowls, 76
Dynamics, 27, 211
Dynamo, 272
Dyonysus, 176

E

Early English (etc.) Style, 208
Ecology, 75, 86, 246
Education, 9, 143
Egypt, 88, 209, 223, 227, 233
Einstein, 36, 193, 268, 277
Electronic calculator, 121 (note), 273
Electron microscope, 18 (note)
Electrons, 18, 268 et seq.
Elegy (Gray's), 159
Elements, 16
Elizabeth I, 93, 186
Embryo, the, 119
Endocrine glands, 112, 113
Energy, 29, 32, 34, 108, 250, 270
Engraving, 202
Enzymes, 109
Eoliths, 83, 84
Epic, 98, 158
Epicureans, 289
Epstein, 193
Eras (Geological), 48, 49, 50, 59, 83
Erasmus, 93
Etching, 202, 203
Ether, the, 35
Ethics, 288
Ethnology, 88, 89
Eureka !, 27
Euripides, 176
Excise, 265
Executive, an, 258 et seq.
Extrovert, 138

F

Fabre, Henri, 69, 163
Factors, 224
Fairy stories, 132
Fashion, 251
Ferro-concrete, 215
Feudalism, 102
Fishes, 59, 107
Fitzgerald, Edward, 169
Flaubert, 169
Food, 113 et seq.
Football pools, 235
Force, 28
For Whom the Bell Tolls (Hemingway), 175
Fossils, 47, 58
Francis, St., 93
Freud, 134 et seq.
Friction, 27, 251
Functionalism, 215

G

Galileo, 29, 41, 281
Gametes, 117
Gases, 30
Gender, 148
Genes, 119, 277
Genetics, 65, 119
Genghis Khan, 93, 103, 104
Georgian style, 213
Geometry, 226
Gibbons, Orlando, 184
Glands, 112, 113
God and Gods, 133, 153, 272, 290
Golden Bough, The (Sir James Frazer), 163
Gothic, 101, 211
Gracchi, the, 93
Graphs, 230
Gravity, 28, 225
Greeks, the, 16 et seq., 34, 51, 97 et seq., 176, 186, 199, 209, 223, 257, 264, 269, 280, 283
Guilds, 103

H

Habeas corpus, 258
Haemoglobin, 110
Hamlet, 18, 173
Hammurabi, 93, 254
Hampton Court, 200
Han Dynasty, 101

Hannibal, 93
Harmonics, 33, 181 et seq.
Haroun, 93
Harvey, William, 107
Heard, Gerald, 144 (note)
Heat, 33
Hegel, 284
Helen of Troy, 92, 93, 97
Henley, W. E., 161
Heredity, 65, 118
Herschel, 41
Hermaphrodite, 65, 118, 277
Herrick, Robert, 160
Hieroglyphics, 90
Hindu, 181, 220, 290
Hogarth, 196, 197
Holbein, 192
Homer, 21, 93, 158, 169, 199
Home of Mankind, The (Van Loon), 51
Homo sapiens, 85, 107
Hormones, 113
Horrabin, J. L., 55
Howard's End (E. M. Forster), 10
Hugo, Victor, 169
Hunger, 250
Huns, 101
Hydrogen, 19, 275
Hydrosphere, the, 46
Hyksos, 93
Hypnosis, 127
Hysteria, 137

I

Ice Ages, 47, 85
Ideal, 282
Ideas, 84, 282
Impressionist school, 197
Incas, 94
Income Tax, 245, 265
India, 88, 99, 199
Individuality, 70, 117
Inertia, 27
Inflation, 243
Inhibition, 127
Insects, 60
Instinct, 69, 128
Insulin, 115
Intaglio, 202
Introvert, 138
Ionic (etc.) columns, 208
Iron, 93, 95, 105
Isotopes, 21, 276

J

Jackson, Holbrook, 162
Jargon, 154
Jason, 251
Jesperson, 145 (note), 146
Jesus Christ, 93, 99, 240
Joan of Arc, 93
Joseph, 93
Judiciary, the, 258 et seq.
Julius Caesar, 82, 93, 100
Jung, 138
Justice of the Peace, 261

K

Karma, 291
Karnak, 206
Keats, 199
Keynes, Lord, 245
King-God, 88, 132
Kno-Hsi, 194
Koran, the, 293
Kubla Khan, 104

L

Lamarck, 58
Lamb, Charles, 159
Language, Birth of, 145
Lào-Tse, 99, 293
Latimer, 82
Latin, 12, 147, 153
Lavoisier, 23, 27
Legislature, 258 et seq.
Leonardo da Vinci, 93
Lewis, Sinclair, 166
Lewis, Wyndham, 213 (note)
Libido, 135
Life force, 58, 290
—— insurance, 235
Light, 34
——, speed of, 36
—— years, 38
Lincoln, Abraham, 93, 105
Lithosphere, the, 46

Lobster, 69, 83
Locke, John, 219
Lodestone, 271
Logarithms, 221, 222
Loom of Language, The (F. Bodmer), 146, 149
Lord Lieutenant, 266
Lungs, the, 111
Lymph, 112

M

McCarthy, Sir Desmond, 163
Macaulay, Lord, 167
Machine Age, the, 199, 214, 252
Maeterlinck, 69
Magic, 132, 290
Magistrate, 262
Magna Carta, 258
Magnetism, 271
Malthus, 246 (note)
Mammals, 62
Maps, 55
Marconi, 93
Marco Polo, 93, 251
Marcus Aurelius, 93
Marx, Karl, 93, 284
Materials, conquest of, 251
Mathematical signs, 237
Matter, 16, 30
Mayor, 263
Medes, 97
Medium (in painting), 197
Mendel, 65, 120
Mercator's projection, 55
Mesolithic, 86
Mesopotamia, 90, 233
Metabolism, 113
Metallurgy, 24, 87
Metaphors, 154
Metaphysics, 281
Mezzotint, 203
Mill, J. S., 239
Millais, 204
Mind in the Making (J. H. Robinson), 129
Mind, 123, 129
Minos, 93
Mixtures, 16
Mohammed, 93, 103, 104, 291, 292
Molecules, 17, 31, 109, 112
Molière, 171
Monarchy, 258 et seq.
Mongols, 101
Montage, 175
Moon, the, 29, 38, 45
Morris, William, 204
Moses, 93, 254
Munro, C. K., 172, 173
Murray, Dr. Gilbert, 288
Museums, 192, 199
Musical instruments, 187
Music and Youth (McMahon), 186
Muses, the, 186
Myth, 133, 290

N

Napoleon I, 93, 166, 235
Napoleon III, 201
National Gallery, 192 et seq.
Natural selection, 64
Nature reserves, 76
Neanderthal Man, 85
Nebuchadnezzar, 93
Nebulae, 40
Neolithic, 86
Nero, 93
Neurasthenia, 127, 137
Neutron, 276
Nervous system, 120 et seq.
Newbolt, Sir Henry, 161
Newton, Sir Isaac, 28, 93, 232
Nirvana, 292
Nitrogen, 23
Nomad, the, 92
Nominalist, 283
Novel, the, 163 et seq.
Nucleus, the, 18, 268, 275

O

Œdipus complex, 135
Old Bailey, the, 262
Oligarchy, 98, 257
Orchestra, the, 185, 187
Organic chemistry, 23
Orion, 40, 42
Osiris, 133
Oxide, 22
Oxygen, 23, 108
Ozone, 21

P

Paleolithic, 83
Parasites, 70, 73
Parliament, 243, 258 et seq.
Parts of speech, 145, 146
Party system, 258 et seq.
Pattern, 23, 66, 67, 71, 118, 191
Paul, 93
Pavlov, 126
Pericles, 93, 207
Persephone, 133
Persians, 97
Persona, 137, 138, 253
Philip of Macedon, 99
Phlogiston, 23
Phoenicians, the, 90, 99
Photography, 190, 203
Photo-synthesis, 72
Phrenology, 125
Phrygians, 97
Piero, 195
Pizarro, 94
Plain Words (Sir Ernest Gowers), 154 (note)
Planck, Max, 268, 277
Planetary system, 19, 40
Plant-animal, 71
Plato, 98, 282
Plutarch, 93
Pluto, 40, 133
Plutocracy, 98, 257
Poetry, 158 et seq.
Pope, Alexander, 288
Potemkin, Prince, 213
Potential (electric), 270
Pottery, 199
Powell, Dilys, 175
Power, 29, 250
Price, 240
Priestley, Joseph, 23
Printing, 104, 201, 203
Prometheus, 133
Protozoa, 74
Pythagoras, 227

Q

Quadratic equations, 225
Quantum theory, 277
Quiller-Couch, Sir Arthur, 150 et seq., 162

R

Races, human, 88
Radar, 273
Radium, 275
Raphael, 204
Rationalizing, 137
Rays, 35, 66
Realist, 283
Recorder, 262
Referent, the, 286
Reformation, the, 103, 105
Refrigeration, 252
Relativity, 277
Rembrandt, 196
Renaissance, 103, 104, 195, 204, 207, 212, 281
Renoir, 196
Reproduction (in art), 201
Reptiles, 60
Reproductive system, 117
Respiratory system, 108, 110
Revolution, French, 103, 105
——, Industrial, 103, 105, 264
Ridley, 82
Rimsky-Korsakov, 184
Rivers, 50
River-valley civilizations, 50, 88
Rocks, Story of the, 47, 58
Rococo, 213
Rodin, 190
Romans, the, 97 et seq., 210, 219
Romanticism, 91, 213
Röntgen, 273
Roosevelt, F. D., 105
Roscellinus, 283
Rousseau, 93
Rupert, Prince, 203
Ruskin, 239
Rutherford, Lord, 274

S

Saga, 98, 158
Saladin, 93
Salisbury Plain, 228
Salt, a, 21
Sampling, 234
Samuel, 93
Samson, 93
Sanskrit, 291

Sassoon, Siegfried, 159, 160, 168
Saxon, 12, 98, 147
Science of Life, The, 71, 111
Scythians, 97
Seasons, The, 52
Semites, 99
Sennacherib, 93
Sex, 64, 117, 131, 135
Shakespeare, 168, 173, 174
Shaw, G. B., 28 (note), 58, 167, 171
Sheraton, 200
Sheriff, 266
Ships, 90, 252
Short History of the World (H. G. Wells), 101
Sial, the, 45
Sima, the, 45
Sitwell, Sir Osbert, 168, 184
Siva, 291
Socrates, 93, 98
Solicitor, a, 261
Solomon, 93
Sophocles, 135, 176
Sound, 32, 182
——, speed of, 33
Space-ship, 51
—— -time, 278
Spectroscope, the, 34, 42
Speech, 84, 127, 151, 158
Stalin, 259
Statute Law, 260
Stone Ages, 83 et seq.
Stonehenge, 209
Strata, 47
Subjective, 124, 190
Sumeria, 90, 223, 254
Sun, the, 37, 42, 46, 73, 203, 246
Sung Dynasty, 93
Syllogism, 284
Symbolism, 131, 133, 135
Syntax, 148
Synthetics, 251
Systems of the Body, 109

T

Tabu, 133
Tartuffe (Molière), 171
Tate Gallery, 197
Television, 272
Tennyson, 161
Thackeray, 165, 172
Theodolite, 228
Thompson, J. J., 274
Thotmes II, 93
Tiger, 38, 63, 162, 194
Timbre, 181
Tolstoy, 169
Tools, 63, 82, 86
Tort, a, 260
Totem, 133
Town Clerk, 266
Town-planning, 217
Townsend, "Turnip", 250
Tracers, 277
Trade cycles, 245
Transport, 251, 252
Trigonometry, 228
Trollope, Anthony, 166
Troy, 92, 97
Turganev, 169
Turks, the, 104

U

Ulysses, 97
Unconscious, the, 134
Ungulates, 62
United States of America, 105, 234, 246
Uranium, 275

V

Valency, 20
Value, 240
Valve (radio, etc.), 273
Vandals, the, 100, 101
Van Eyck, 195
Vanity Fair, 165
Vedas, the, 291
Vegetable kingdom, the, 71
Velasquez, 157, 193, 196
Vertebrates, 67, 68
Victoria and Albert Museum, 193, 198
Victoria, Queen, 93, 164
Virus, 74, 113
Vitamins, 114 et seq.
Voltage, 271

W

Wavell, Lord, 161
Waves, 32, 35, 273, 274
Wealth of Nations, The (Adam Smith), 239
Wells, H. G., 29, 55, 101, 166, 267
Western Tradition, the, 294
What Happened in History (Gordon Childe), 96
William the Conqueror, 39, 93
Williams-Ellis, C., 216
Woolf, Virginia, 162
Work, 29, 250
Writing, 89, 90, 151
Writing, The Art of (Quiller-Couch), 150 et seq.
Wyatt, Sir Thomas, 160

X

X-ray, 35, 272, 275

Y

Yeast, 73, 87

Z

Zero, 220
Ziggurat, 206

Man – Antiquity
Antiquity – Man