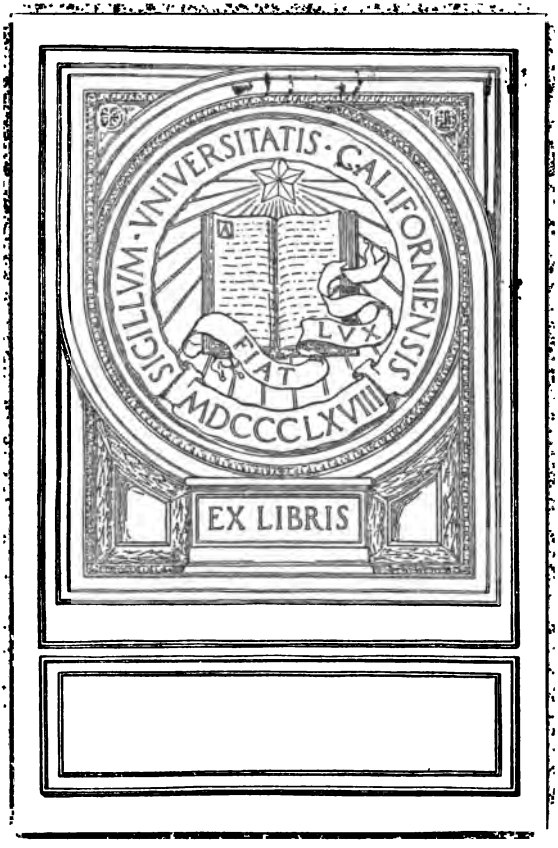
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THE ALCHEMIST.

From a painting by Joseph Wright of Derby.

[*Frontispiece.*

ALCHEMY

ITS SCIENCE AND ROMANCE

BY THE
RIGHT REV. J. E. MERCER, D.D.
SOMETIME BISHOP OF TASMANIA

WITH FOUR ILLUSTRATIONS

LONDON
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CHRISTIAN KNOWLEDGE
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PREFACE

THIS may perhaps claim to be an apology for Alchemy. It attempts to set forth, with more of system and of sympathy than is usual, its history, the doctrines it professed, and the results it achieved. It must not, however, be thought that the apologetic intention of the study implies any failure in recognising the weaknesses and follies which abounded in the development of the art, nor the chimerical nature of the means adopted for solving its Grand Secret. The defence is based on a critical estimate of the conditions under which the genuine adepts had to think and work.

I have consulted the works of representative alchemists, especially of the earlier periods. But I lay no claim to detailed research throughout the whole vast range of the literature of the subject. Even Berthelot had to specialise. I have availed myself freely of materials which are more or less easily accessible in modern treatises on the Hermeitic art. I gratefully acknowledge my indebtedness to the above-mentioned author, and, though in less degree, to such studies as those of Figuier, Muir, and Thorpe, as also to a carefully written article in Hastings' *Encyclopædia of Religion and Ethics*. Fortunately the main features of the subject stand out clearly; a

study of tedious and generally unintelligible detail is unnecessary. What I venture to question is not the evidence, but the justice of the condemnations so often founded upon it. I contend that when we make fair allowance for the conditions under which the genuine alchemists did their work, we shall acknowledge their right to rank as true scientists and discoverers. To judge them from the standpoint of the present is hopelessly irrational.

J. EDWARD MERCER.

February 8, 1920.

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ALCHEMY—ITS SCIENCE AND ROMANCE

INTRODUCTION

The Art and its Appeal

OUR subject is alchemy—that baffling art, with a record so ancient and yet so tarnished. The strong stream of modern science has swept over it, leaving it shattered and forlorn. It has fallen on evil days, and has almost passed out of remembrance. And yet, when sympathetically studied, it abounds in varied interests, for the poet, the historian, the philosopher, and for the scientist himself. It numbered among its adepts some of the most picturesque and the most famous personages in the annals of European civilisation. It welded philosophic speculation and operative toil; mysticism, magic and technical skill. It lost itself in the wildest aberrations, and yet issued in modern chemistry. It thus presents a unique medley of attractions which gain in their power of appeal in proportion as the rigidity of modern Materialism is softened and humanised.

What Alchemy aimed at.

If we ask what the objects were which the art so strenuously sought to attain, the answers are not as

simple as many would imagine. One of them stands out prominently in the popular mind—the discovery of the Philosopher's Stone which was to transmute the baser metals into gold. But alchemists aimed at far more than this. In constant rivalry with the hope of making gold and silver was that of discovering a remedy for disease, a universal medicine. The two objects tended to run together, because of the frequent identification of the Stone and the Elixir. The latter, by a natural extension of the idea of a master-power, was to renew the vigour and graces of youth, nay, it was to effect an indefinite lengthening of the term of life. Further, adepts claimed that their wondrous remedy would give intellectual and moral excellence, happiness, influence with the spirit world, communion with the Creator. Thus were the aims of the art expanded until they embraced transmutations, not of metals only, but of human beings, and the control of powers which reached out into the universe at large.

But the art, it will be said, never attained its objects, it was delusive; and is therefore unworthy of serious study. Such an inference is easily shown to be hasty and superficial. Delusion undeniably bulks largely in the history, and raises in an acute form the curious problem of its function in man's intellectual and spiritual evolution. But delusion is not the whole tale. In searching for the Stone and the Elixir, real substances had to be handled, real experiments had to be made. It could not, then, be otherwise than that there should accumulate a body of empirical facts concerning the nature of the substances and their mutual reactions. Moreover, even

the charlatans had their part to play, in that they helped to keep alive the interest in alchemical pursuits.

Alchemy compared with Magic and Astrology.

Bacon has a suggestive passage in which he groups together three kindred pseudo-arts. "As for the facility of credit which is yielded to arts and opinions, it is of two kinds: either when too much belief is attributed to the arts themselves, or to certain authors in any art. The sciences themselves which have had better intelligence and confederacy with the imagination of man than with his reason, are three in number: Astrology, Natural Magic, and Alchemy; of which sciences nevertheless the ends or pretences are noble. For astrology pretendeth to discover that correspondence or concatenation which is between the superior globe and the inferior; natural magic pretendeth to call and reduce natural philosophy from a variety of speculations to the magnitude of works; and alchemy pretendeth to make separation of all the unlike parts of bodies which in mixtures of nature are incorporate." *

A few comments on the points here raised will help much to an understanding of how a pseudo-art could flourish for so long a period, and of why it is worthy of continued attention. We note in the first place that it gained "facility of credit" on both the grounds mentioned by Bacon. It was cultivated by men of repute who imagined that either they themselves, or others, had genuinely solved the great secret

* *Advancement of Learning*, Bk. I.

of the Philosopher's Stone, and it thus gained an amount of solid prestige which survived constant failures and disappointments. It was also in the same case as astrology and magic through the strength of its appeal to the emotions. Spurred on by the dazzling hope of wealth and all that wealth can give, and by the desire to conquer disease and natural decay, even clever men allowed their imagination to sway their reason. The slenderest chances of success sufficed to keep the fire of enthusiasm aglow.

Astrology sought to bring star-lore into relation with human life; magic sought to bend the powers of nature to human wills; alchemy laboured to manipulate substances for the satisfaction of human needs. In spite, then, of the errors and vanities which marred, and too often debased, these arts, their ends, as Bacon says, were noble. Their fortunes, as we shall see, were intimately linked together; and they all three alike gave birth to sciences which are among the chief glories of our own times. Astrology merged in astronomy, natural magic in physics, and alchemy in chemistry. The differences in the rates of merging do not affect the nature and the significance of the principles and processes involved. Accretions of ignorance and superstition were gradually stripped away, and the accumulating store of facts formed the nucleus for greater and more solid triumphs.

Mathematics and physics were the first to free themselves from the entangling creations of imagination. For their early emancipation they have to thank the comparative clarity and precision of their subject matter. Astrology was for a longer time cultivated on its emotional side as a means to

foretelling, and even changing, the future. Alchemy was in the worst case of all. For, until quite recent times, men had no guides in the unravelling of the complex and subtle mazes of chemical reactions other than a medley of loose analogies and vague hypotheses. Advance in this sphere of research was necessarily slow and painful. Nevertheless Liebig is justified when he asserts that "alchemy from first to last was chemistry."

Psychological Aspects.

Our subject is also replete with psychological interest. The story of the art brings before us, during a long series of changing centuries, amid varying stages and types of civilisation, the influence of emotion in the pursuit of an absorbing aim. Is there not here material for putting to the test many of the tendencies to mystic and occult speculations and practices which manifest themselves so persistently in all ages, not excluding our own? Undoubtedly there is a place for these. The world is in reality a temple of mysteries, and there is perennial truth in the much-quoted aphorism that there are more things in heaven and earth than are dreamt of in our philosophy. Notwithstanding, the errors and follies of the alchemists serve to put us on our guard against allowing the critical faculty to be swamped by a dominant set of keen desires, of deep cravings, or of soaring aspirations.

If it be urged that our own age has outgrown such weaknesses, psychology utters a warning note, and can moreover appeal to a sufficiently disturbing

array of facts. It bids us distinguish between the hereditary structure of the individual mind and the environment which provides that mind with stimulus for its development. True, our environment has vastly improved; but our minds are fundamentally the same as those of our forefathers. A realisation of this fact will mitigate our condemnation of former credulities, and will likewise make us less confident of the immunity of our own generation.

Romance.

It is possible, then, to justify, even from a utilitarian standpoint, a serious consideration of what alchemy was and what it achieved. But its romance constitutes a further claim. For it abounds in the wild, the fantastic, the uncanny, the marvellous. From the outset it has had a fascination for artists, poets, playwrights and novelists. In early mediæval days a certain Aurelius Augurella employed the medium of verse in which to expound the mysteries and practices of the art, and with no inconsiderable success. Jean de Meung (1275), the famous author of the *Roman de la Rose*, was a firm believer in alchemy, and makes it the subject of two of his shorter poems. Ben Jonson is at his "rarest" in his play, *The Alchemist*, which many consider his finest work. Goethe in his *Faust* brings it to the fore. Writers of fiction innumerable have exploited its resources to enhance their plots—Scott in his *Antiquary* being not the least notable example. Browning has chosen for the hero of an ambitious poem, Paracelsus, one of its most astonishing professors. Artists have exploited

its picturesque accessories—its presiding sages and its mysterious apparatus. Lovers of allegory and symbolism can revel in its mystic serpents, interwoven triangles, salamanders, dragons, and the like weird creations of unfettered imagination. The store is inexhaustible.

It would be inexcusable to contend that modern science has not its elements of romance. The story of its conquests teems with human interest and deepens our sense of the mystery of the universe. But when all is said on this score that can be said, we have to acknowledge the loss of a peculiar charm; the cold depersonalised methods of the present-day experimenter impose on us a burden of hard facts which limits the free rovings of phantasy and chills romantic fervour. There is no easier or surer way to get back into the olden world than to share for a while the hopes and labours of the alchemists.

Division of the Subject.

It would be artificial and cumbersome to treat separately each of the sources of interest above enumerated. It will be profitable, however, to distinguish the history of the art from its philosophy and its science, and to devote to these the larger divisions of our subject. We shall thus be preserved from desultory wanderings. Let us therefore proceed as follows.

We cannot hope to understand the details of the story until we have secured a bird's-eye view of its general course. We will begin, then, with a sketch of the history of the art from its origin to its decadence

and thus obtain a framework into which persons, happenings, discoveries, may be fitted. Then may come a closer consideration of the ruling ideas which guided the development of the art; and of the technical skill, methods, and materials which conditioned it. The way will thus be clear for admiring the virtues of those illusive substances, the Philosopher's Stone and the Elixir of Life. Next will come an attempt to estimate the amount and the value of the contributions made to positive science. And lastly we will ask whether the art be really dead; or whether, rather, it is not taking a new lease of life, and promising to attain results which may surpass anything that could be suspected or imagined by the sages of a bygone day.

PART I

GENERAL HISTORY

CHAPTER I

MYTH AND EARLY HISTORY

WHEN did alchemy begin its long career? The question cannot be answered with any certainty. Trustworthy evidence is lacking. It is known, indeed, that it has an ancient ancestry. But not until the fall of the Roman Empire does it emerge into the light of valid history. This much, however, can be inferred, that the art properly called "alchemy" arose in the second or third century of the Christian era, and that it resulted from a union of the practical art of the Egyptians with the philosophy of the Greeks, and with the mysticism which found its home in Alexandria. Let us take careful note of this triple conjunction; it is of fundamental importance.

Mythical Accounts.

The origin of alchemy is ancient even when traced back no further than the second or third century of our era. But the adepts and historians of the art were by no means thus easily satisfied, and sought to invest it with the imposing dignity of a hoary antiquity. Some of them were very bold and claimed Adam as its founder, with the naïve desire of making it as old as the race. The loss of the secret came with

the loss of Paradise. Olaeus Borrichius is on somewhat firmer ground when he fixes on Tubal-cain, the famous smith of the Bible, for it is certain that the metallurgy of primitive times provided the practical basis of alchemy. Noah was enlisted among these patriarchal adepts. It was argued that he must have possessed the Elixir of life, otherwise he could not have begotten children when he was five hundred years old. The contention, however, is not quite convincing.

A supposition of a very different and far sounder kind is advanced when the word "alchemy" is derived from the name Shem, or Chem, the son of Noah. But even were the name Chem proved to be in evidence, we should not on this score conclude, with a seventeenth-century *History of the Hermetic Philosophy*,* that Shem was an alchemist!

Once started on this track, historians could not fail to enrol Moses. Was he not learned in all the lore of the Egyptians, and would not alchemy be included? Moreover, it is recorded that when Moses was angered at the idolatry of the Israelites, "he took the calf which they had made, and burnt it with fire, and ground it to powder, and strewed it upon the water, and made the children of Israel drink of it." Here, they triumphantly infer, is proof positive that he had the Philosopher's Stone. For how, save by its agency, could he have made the gold powder float on the water? And if it be objected that there is no trace of knowledge of the Stone in the subsequent narratives, the answer is ready. Moses kept the knowledge to himself, and would never entrust the secret to his people.

* Longlet du Fresney, born 1674.

Solomon was even more certain to be claimed as an adept. For he was widely held to be a master of occult and magical arts, and was possessed of enormous stores of gold. Clearly he knew the mysteries of transmutation. Yes, said early higher critics, he had gold; but if he could make it, why did he go to so much trouble and expense to send to Orphir? This obvious objection was parried by the supposition that, determining to keep the secret, he had the metal carried there and brought back again, in order to mislead the people as to its real source!

Hermes Trismegistus.

Of much greater significance is the claim that the art was founded by Hermes Trismegistus—the Thrice-greatest Hermes. He was an Egyptian priest, supposed to have lived about 2000 B.C., widely revered as the inventor of all the useful arts, and, on that account, in course of time elevated to the rank of the gods. So closely was his name connected with alchemy that "the Hermetic Art" came to be a synonym for it. His mystical hymn was often recited and quoted by the adepts, as an authoritative statement of one of their earliest and most characteristic doctrines—that of the unity of all that exists. "Universe, be attentive to my voice; earth, open; let the mass of waters open to me; trees, tremble not. I would praise the Supreme Lord, the All and the One. Let the heavens open and the winds be still; let all my faculties praise the All and the One." The bearing of this on our subject will be considered when we treat of the philosophy of alchemy.

The significance of the prominent place given to Hermes lies here. It was undoubtedly the metallurgical and chemical knowledge and skill possessed by the Egyptians that started the idea of the practical possibility of transmutation. From the earliest times that pioneer civilisation worked with metals and alloys, with the making of glass and enamel, and with the concoction of medicines. And Berthelot has shown that it is the material thus accumulated which is embodied in the oldest treatises on alchemy, If, then, we take Hermes Trismegistus to be the representative of a whole succession of Egyptian priest-metallurgists, instead of a single individual discoverer, the claim on his behalf may be accorded a large measure of validity.

We must be careful, however, not to press the claim too far. For this core of historical fact was overlaid by enormous accretions of myth and fantastic legend. Nor can we wonder that this should have happened. For during the whole of our Christian era there has been a widely spread conviction (not yet extinct!) that the ancient Egyptians had discovered many secret arts, occult doctrines, and magical formulæ which had been lost to the world. The veil that hung over the ruined retreats at Thebes and Memphis, the ignorance of what was known and practised there, allowed free play for imagination and cast a glamour over the little that had survived. Mediæval sages (and not a few moderns) firmly believed that the bizarre signs and emblems of that almost obliterated past concealed secrets and revelations of the deepest import. Hence exaggerations and absurdities. The fact nevertheless remains that

this ancient metallurgy gave a starting-point for alchemy properly so called.*

At last, then, we approach the confines of history. We have discovered the existence in Egypt of a large accumulation of the kind of materials with which alchemy concerned itself. Jewellers, painters, potters, glass-makers, and pre-eminently metal-workers—each craft had its own store of technical secrets handed on generation after generation by personal instruction as between masters and apprentices. Doubtless there were also manuals and treatises; but these have not been preserved, and in any case played a quite subsidiary part. Berthelot lays great emphasis on the importance of such professional tradition. He contends that the Egyptian lore was in this way transmitted to the artisans of Rome, preserved during the Dark Ages in the workshops of Italy and France, and gradually absorbed into the general body of alchemical doctrine and practice.

The Idea of Transmutation.

Although we are now in touch with historical facts, we have not yet reached the time when testimony derived from contemporary documents is available. We have to trust to inferences more or less probable from statements found in later records. And it is in this period of semi-obscurity that we have to find the rise of the idea of transmutation. Can we succeed? Certainly not by tracing any series of

* For detailed proofs, see Berthelot, *Les Origines de l'Alchimie*, *passim*, especially pp. 31 ff.

specific happenings, as is so often possible in the case of scientific discoveries in modern times. Still, it is possible to surmise how men came to think that the precious could be made from the baser metals.

How about those goldsmiths and metal-workers in Egypt? They would soon observe that certain alloys of metals could be compounded which closely resembled gold and silver. Now would they be slow in putting to use their knowledge, some legitimately, others illegitimately. The dishonest artificers would get great gain from debasing the precious metals and from uttering false coinages, being thus the precursors of the fraudulent alchemists who flourished to the end of the long history.

But alchemy, as we have seen, aimed at more than producing alloys that resembled gold or silver; it laboured for genuine transmutation. How came it about that there arose an honest belief in the possibility of this process? A full answer to the question would anticipate too much our study of the three conjoining factors—knowledge of technical processes, Greek philosophy, and Alexandrian mysticism. But speaking quite generally, may we not safely imagine that something of this kind happened?

Certain workers in the making of these alloys were really puzzled by the results of some of their experiments. With the imperfect means of analysis at their command, they would at times be deceived into thinking that they had perceptibly increased the amount of the precious metal they were treating. By way of reinforcement of a growing suspicion of success, there would come to the minds of the more learned of them the Greek doctrines concerning the one substance

out of which all others were supposed to be compounded. And further, there would be a keen edge put upon their research by the hope of a sure and easy way of multiplying their wealth. Under the sway of these converging influences, it is not difficult to see how a craftsman might become an alchemist. For when once the idea of transmutation had begun to take definite shape, it would speedily establish itself with peculiar strength. The magnitude of the stake would fire the imagination, and would lead to specialised concentration of effort. Alchemy would thus be launched on its extraordinary career.

Early References.

Supposing the above surmise to be somewhere near the mark, we ask whether there is any evidence, direct or indirect, which would lend it support. Fortunately such does exist, and is valuable, though all too scanty. This much is clearly proved, that in the earliest centuries of our era there had come into being a definite class of operative chemists who made it their business to effect genuine transmutation. They were not alchemists in the full sense of the term, but were well on the way.

The authorities for justifying this statement are at first authors who make mere incidental and matter-of-fact allusions to an accepted belief in the possibility of transmutation.

The first bit of testimony I shall adduce is from an author of uncertain, but very early, date (first century)—Manilius. He wrote a poem entitled *Astronomica*, in which he did his best to embellish

the dull details of his astrological and astronomical themes. In the fourth book he discourses on the action of fire. He tells how fire makes possible "the search for hidden metals and for buried riches, the calcining of veins of minerals, and the special art of doubling the material in the case of articles made of gold and silver." * In this passage we have mention of the process of "doubling" the precious metals, brought in with no idea of a necessity for explanation; and yet it of course implies transmutation.

The second allusion to be quoted is to be found in Pliny the Elder. He records that the Emperor Caligula, greedy of gold, ordered a large amount of orpiment (arsenic sesquisulphide—a yellow powder) to be calcined; that the result was some excellent gold; but that the amount of it was so small that it did not repay the cost involved.† We may not be warranted in taking this to mean transmutation; but at any rate it does mean artificial manufacture. Berthelot thus comments on the passage: "The fact in itself, such as Pliny reports it, is nothing else than probable; for it seems that we have here an operation analogous to cupellation (refining), having for end and result the extraction of the gold contained in certain compounds of sulphur with metals, distin-

* "Quidquid in usus
Ignis agit. . . . Scrutari cæca metalla
Depositas et opes, terræque exurere venas,
Materiamque manu certa duplicarier arte
Quidquid et argento fabricetur quidquid et auro."

† "Invitaverit spes Caium principem avidissimum auri, quamobrem jussit excoqui magnum auripigmenti pondus, et plane fecit aurum excellens, sed ita parvi ponderis, ut detrimentum sentiret" (Bk. xxiii, ch. iv).

guished by their colour as possibly containing gold. The extraction of pre-existing gold, or the making of it out and out, these are two ideas quite distinct for us; but they were confused in the minds of ancient operators" (*Les Origines de l'Alchimie*, p. 69).

The two passages just quoted are not quite, though nearly, free from suspicion. There is, however, no doubt cast upon a testimony which points to the time of Diocletian (284–305). Suidas, a Greek lexicographer (*c.* 975–1025), tells us that this Emperor ordered all Egyptian books on the making of gold and silver to be burnt. We are thus taken back to practically the same time as by Manilius and Pliny—a time which was noted for secret and magical arts and writings. Alchemy was plainly on its way, but had not attained to the dignity of an art of transmutation.

The Papyri of Leyden.

The oldest authentic documents in existence dealing with this early phase of the art are certain groups of manuscripts stored in the libraries of Leyden, Venice, and Paris. They are not treatises on alchemy, but rather guides to the technical practices of the chemistry of their period. The most ancient of them are in the Leyden collection, and on the score of their historical value and characteristic contents call for a brief description and critical notice.

According to Berthelot, the greater number of this collection are Egyptian, dating from the third century, and so of the same order as those destroyed by order of Diocletian. They were probably found

together in the tomb of some magician of Thebes. They contain, in intimate association, magic, astrology, the study of metallic alloys, dyeing, and the virtues of plants. Here is a heading which displays a singular combination of magic and gold-craft. "How to make a ring that shall act as a talisman, by graving on a jasper, set in the ring, the form of a serpent which bites its tail, the moon with two stars, and the sun above."

From the more specially alchemic point of view, we remark a number of receipts for working metal and alloys, and descriptions of methods of imitating and falsifying gold and silver. There is, for example, an explanation of how a white colour may be given to certain metals by the use of arsenic; and how, by the addition of cadmia, copper acquires the colour of gold. All this is leading up to a belief in the possibility of real transmutation. And, indeed, we actually find paragraphs treating of the multiplication of gold by forming alloys. We recall the "doubling" alluded to in the classical authors previously quoted. The idea was evidently taking possession of the nascent alchemists.

The Mystical Factor.

These ancient manuscripts also give us a glimpse into the manner in which magic and mysticism blended with practice and philosophy—the third factor contained in alchemy properly so called. So strong is the thaumaturgical ingredient that it points to Alexandria, that great home of mysticism, as the actual centre in which the Hermetic art had its origin.

There was, in that seething centre, a medley of philosophy, magic, and religion which was bound to influence all whose thinking was, directly or indirectly, brought into contact with it. And in these treatises we see how spells and incantations were brought to the aid of technical formulas. It is obvious that the supposed co-operation of unseen powers would tend to develop the idea of real transmutation; for the barriers set by ordinary experience of the natural order would be evaded or ignored when there was expectation of supernatural intervention.

Spread of the Art.

We may be sure that from Alexandria, as the originating centre, a knowledge of the new art would spread to most of the great cities in the Roman Empire. The arts, superstitions, religions, and speculations of the East invaded the Western world—and alchemy would travel with the rest. More especially did it find a congenial home in Constantinople, the city in which so much art and learning were fostered and granted a refuge in the troubled days of Rome's decay and fall. And it is from Alexandria and Constantinople that there issued most of those Greek treatises which ensured the preservation of the Hermetic art. Many of them were lost; others were buried in forgotten libraries; others fell into the hands of the Arabs, were translated into their own tongue, and so were the means of setting the idea of transmutation in a new environment.

It is in one of these Greek treatises, written about the end of the fifth century by a certain Æneas

Garæus, that is found what is said to be the earliest mention of alchemic transmutation. Be this as it may, the work is of much broader historical interest as a specimen of its class. It is what we should anticipate from a period of decadence. Boerhaave, in his *History of Chemistry*, says of these writers that, "from this great laziness and solitary way of life, they were led into vain enthusiastical speculations to the great disservice and adulteration of the art."

Since it thus appears that the rise of alchemy was, roughly speaking, contemporaneous with that of Christianity, it is natural to ask what sort of relations were maintained between ecclesiastics and adepts. The question will come up again. Here it will be sufficient to say that, whether from conviction or from prudential motives, alchemists managed to adjust themselves to the new religious order, and so escaped official condemnation. In after days they did not succeed so well, though their art was never completely banned.

At the close of this preparatory period, then, we find that alchemy had become extinct in the Roman Empire. Wars, revolutions, invasions, crushed it out. We now turn to see how it was resuscitated by being adopted into an alien civilisation.

CHAPTER II

ARABIAN ALCHEMY

IN the seventh century Egypt was invaded by the Arabs, and for a time its affairs were thrown into dire confusion. But when the conquerors had settled down, they began to interest themselves in the speculations, arts, and sciences they had suppressed. The Alexandrian form of the Hermetic art, among others, was given a new lease of life, and attracted to itself many devoted students who were very genuine chemists.

The Testimony of Words.

We owe to this Arabian era certain words which in some cases are pure Arabic; in others, Greek words preceded by the Arabic article, *al.* Such are *alcohol, elixir, alembic, aludel.* The word *alcohol,* for instance, is *al-kohl*—kohl being a fine black powder, used still by Oriental ladies for darkening eyebrows and lashes. The use of the word was extended to various powders and liquids, and was at last attached to the particular group of liquids now known as the alcohols. As an example of a Greek word adopted we may take *elixir. El* is of course the Arabic article; the *ixir* is said to be the Greek *xerion,* meaning *dry powder.*

But it may be pure Arabic, *iksir*, from a root *kasara*, meaning "to grind."

The chief of this group of words is *alchemy* itself. It would seem to be in line with those above; but its origin is much disputed; and a glance at the rival derivations will be not only interesting etymologically, but will give us some valuable side-lights on the history of the art. As was pointed out in the last chapter, one derivation would link it to Shem, or Chem, a son of the patriarch Noah. If we substitute another son, Ham, or Cham, the case is by no means desperate; for there is little doubt that this word is the Egyptian name of Egypt, and we have seen how closely this country was concerned in the founding of alchemy. We need not, then, seek for a purely Hebrew meaning, as those do who refer it to the Hebrew *chaman*, a *mystery*. It is safer to follow the lead of Plutarch, who tells us, in his treatise *Isis and Osiris*, that in the sacred dialect of Egypt, the country was called Chēmīa, the same word as that used for the black of the eye. The name would thus be descriptive of the blackness of the soil. There are still some authorities who think that Plutarch was on the right track. And strongly in his favour is the fact that the arts which provided the practical part of alchemy were peculiarly Egyptian.

Other authorities, however, argue that alchemy is one of the terms resulting from prefixing the Arabic article to a Greek word. There is a Greek word, *chemia*, which appears in the decree of Diocletian, before mentioned, against "the makers of gold and silver." And a commentator on Aristotle, writing in the fourth century of our era, calls attention to various

vessels and instruments used for fusion and calcination which were named *chuika organa*—that is, apparatus for melting and pouring. It is to this set of terms that many would refer the substantive part of the word "alchemy."

Perhaps the dispute is best settled by declaring that both contentions are sound!—and this, not by way of convenient harmonising, but on grounds of historical probability. The suggestion thrown out by Plutarch would make alchemy mean *the Egyptian art.* The Greek derivation would describe its chief processes, melting and pouring. May there not have been an early confusion of the Egyptian *chemia* with the Greek *chumeia?* It would be reflected in the difference of spellings—*alchemy*, and the Renaissance *alchymy*—contained in our *chemistry* and *chymistry.* Both forms would thus be defensible, though the former has the greater weight of authority. And we should also have a reference to each of the two countries which contributed to the founding of the art—Egypt supplying the practical part, and Greece the speculations on the nature of matter which offered a rational basis for the idea of transmutation. Then, the prefixing of the Arabic article testifies to the importance of the Arabian phase of its development.

In any case, the art of transmutation, so far as we know, is first called *alchemy* in the sixth and seventh centuries. In its earlier stages it had no special name, but was known as "the sacred art," "the Hermetic art," the "divine science," and other designations of a like kind, many of which were retained right through the history, though "alchemy" came to the front.

Documents.

So much for derivations. Let us turn to consider what form the art assumed in the hands of the Arabs. The mass of documents which claim to be Arabian is very great. But inasmuch as, in later times, many impudent forgeries were issued in the names of famous adepts, it is matter of great difficulty to sift the true from the false. I shall keep to the evidence which is most generally accepted as trustworthy, relying specially on the researches and conclusions of Berthelot in his splendid treatises on this subject.

The oldest of the documents are three ascribed to Halid (704 A.D.), who was reputed to have had for master a Syrian monk to whom he dedicated a treatise. There seems to be no good ground for doubting the tradition. At any rate, the dependence of Arabian alchemy on the Greek is clear as daylight. The Arabs, however, did not simply take over their material without modification. Many of the fantastic features which Boerhaave condemned so severely in the Greek alchemy were abandoned, and the art was mainly practised as a means to healing. This change came about because the Arabian adepts were mostly physicians who devoted themselves to chemical medicines. It is curious to note that the final phase of the art, with Paracelsus as its prophet, was likewise chiefly concerned with healing. The wheel came full circle.

Geber.

The most famous name is that of Geber, whose life is assigned to the end of the eighth century.

Little is known about him. But he was illustrious in his own right, and became still more so in the Middle Ages when he was honoured by being made the subject of numerous legends. No less than 200 works are ascribed to him! It can be easily imagined that, in his case, the distinguishing of genuine and spurious is extremely hazardous. Even those which bear marks of authenticity, though free from many of the absurdities of later periods, abound in obscure terms and modes of exposition. It is amusing to find Dr. Johnson deriving "gibberish" from his name. Needless to say, he was wrong.* The mere fact, however, that such an error was possible shows what impression had been made on the minds of those hardy enough to explore those tangled disquisitions. Recent critics, with fuller and better opportunities for understanding what Geber wanted to say, put a high estimate on the value of his work.

The titles given to these treatises are usually symbolic, such as *The Book of Royalty, The Little Book of Pity, The Book of Balances, The Book of Concentration, The Book of Oriental Mercury.* They contain matter which is strangely mixed, and include formulas and receipts which embody what was known of chemistry at that period. Let us glance at the contents of one of these—*The Book of Royalty.*

The author sets out, as usual, with the Muslim formula—"In the name of God compassionate and merciful"—and asks for blessings on Mahomet and his family. He then proceeds: "The present little work is one in which I have specially indicated two classes of operations. The first is that in which

* "Gibberish" is really akin to "gabble" and "jabber."

execution is rapid and easy; for princes do not feel themselves drawn towards complicated operations, not being able to undertake them. The second, or inner work, is that which sages only execute for princes. That is the reason why I have given to this treatise the name *Book of Royalty*. Seize firmly, my brother, what I am going to expound in this work, and the thing will appear easy to you, if you are a clear thinker. I swear it by my master. . . . But for heaven's sake, my dear brother, do not let this facility lead you to divulge this proceeding, or to show it to any of those around you, to your wife, or your cherished child, and still less to any other person. My dear brother, if you do not heed this advice, you will repent of it when repentance is too late."

He quotes with approbation the saying of the ancients: "If we divulge this work, the world will be corrupted; for gold would then be made as easily as glass is made for the bazaars." And yet, he could not make it! A needless warning!

The main body of the treatise is occupied with descriptions of operations for concocting "the Elixir of Elixirs, the ferment of ferments, which will transform the elements at the same time that it transforms itself." They are seemingly simple, but, in reality, unintelligible. The author does, indeed, allow that while he has spoken of what he calls "the balance of water" in plain terms, he has wrapped up his instructions about "the balance of fire" in terms "enigmatic and a little complicated." Illuminating is his concluding paragraph. "In all this, dear brother, the fundamental principle is that the elements of the Iam (them transmuting Essence)

should be well purified and freed from the oils which corrupt it, and which hinder it from producing its effect." That is to say, there was unvarying failure; but this was due to impurities in the ingredients, not to the vain character of the alchemist's quest. It is fair to Geber, however, to point out that he himself was not free from graver doubts; he seems to have been a naïve, but certainly he was an honest man. Moreover, he was a reformer. In one of the treatises * most assuredly attributed to him, he uses logical arguments to defend his art, discarding and denying certain opinions regarding the influence of the stars on the production of metals. Like most of the Arabians, he had no small share of the scientific spirit.

Another enthusiastic student of this school, who lived in the tenth century, was the medical philosopher Rhazes. There are several important treatises which bear his name. One of these brought him misfortune. He had written a plea for art entitled *The Establishment of Alchemy*, and presented it to his prince. His royal patron asked him to verify some of his experiments, and finding him unable to comply, struck him so violently across the face with a whip that he blinded him.

Many other Arabian alchemists there were, of greater or less fame, though these two names stand out from among them. Speaking generally, we may accept it as proved that under the Caliphs alchemy had a comparatively wholesome career, and made a distinct contribution to the movement which raised an industrial to the rank of an experimental art.

* *Summa Perfectionis Magisterii in sua Natura.*

The Spread of Arabian Alchemy.

Once firmly established in the East, alchemy was carried into all the countries affected by the triumph of Arab arms. It was thus that, in the eighth century, it reached Spain, where it was enthusiastically cultivated in those centres of learning which are deservedly so famous. By the time of the Crusades, that is to say, towards the twelfth century, it was beginning to travel into other European countries, and to merge with the general stream of Western civilisation. The idea of transmutation thus acquired a new environment, and took on the complexion of mediæval thought. Before passing to the consideration of this next phase of the art, it is interesting to note that Islamic alchemy, though moribund, is not even yet extinct. In Morocco, in Mecca, and other places, there are individuals who cherish old treatises, and jealously guard them. The hope that stirred their renowned ancestors still burns in their breasts. They believe that the Philosopher's Stone was really discovered, and that the secret of its production is recorded. Ah! What if the hard formulas could be interpreted! Their Geber's boast would be vindicated—gold would be "made as easily as glass is made" for their unchanging bazaars.

CHAPTER III

MEDIÆVAL ALCHEMY

FROM Spain, then, alchemy spread out through the Western nations. The process of expansion was so steady that, by the time the Arab rule was overthrown, the future of the art was safe. By the fifteenth century it was cultivated throughout the whole of Christendom, and in the seventeenth attained the apogee of its success. The prominence it attained in the Middle Ages is manifest when we run through a list of the famous men who believed in it, practised it, and wrote about it—such names as Raymond Lully, Roger Bacon, Albertus Magnus, Thomas Aquinas. As in the case of the preceding period, the multitude of spurious treatises renders it exceedingly difficult to distinguish fact from fiction and to form reliable historical estimates. But there is this advantage over the earlier sources, that the pseudo-literature nearly all appeared within the limits of the period it concerns, and can thus be used as at least reflecting the ideas, doctrines, and practices which characterised it. A fair number of authorities are above suspicion. By putting true and spurious together, it is possible to gain a full and living picture of mediæval alchemy. The simplest way of going to work is to study the teaching and activities of a

few representative adepts—not biographically, but merely in so far as they throw light on our particular subject.

Gerbert and Michael Scott.

The complete dependence of mediæval alchemy on the Arabian is manifested by the fact that the first Western students gained their knowledge in the Spanish universities. An illustrious example is found in Gerbert, afterwards Pope Sylvester II (999–1003). As a young man, he attracted the attention of Borel, Count of Barcelona, and went with him to Spain, where he studied science and philosophy, more especially chemistry. His attainments were so great that, after the manner of the times, he was reputed to be in league with the devil. It would seem that such a charge should have put an end to his chances of ecclesiastical promotion. He was, however, made Abbot of Bobbio by Otto II, became Archbishop of Ravenna, and then climbed into the Papal chair itself. His career thus not only proves dependence on Spain, but shows that an alchemist could attain to the highest office. He was the precursor of a long series of men of note who honoured the art by being adepts. Perhaps it might be more accurate to call him a chemist than an alchemist; but the distinction is hardly worth drawing, as the two classes were in those days inseparable.

We descend 200 years to come to Michael Scott. The Muslim influence was still great; for we find that he studied Arabic in Sicily, and spent ten years in Spain. Frederick II became his patron, and it

was to this monarch that in 1209 he dedicated a treatise, *De Secretis*. He did much to bring the art into notice, but apparently in doubtful guise. For Fergusson writes thus: "At Toledo he learnt magic for which the city was famous—natural magic or experimental physics or jugglery, as well as black magic, involving the invocation of the infernal powers. There, too, he experimented in alchemy." Evidently the magic was much in evidence!

Albertus Magnus.

Contemporary with Michael Scott was a man of a very different type, Albertus Magnus—an alchemist in the best sense, and also one of the most distinguished men of his time. He was a Dominican monk, and became Bishop of Ratisbon. After three years, he resigned his see to devote himself to his studies. While cultivating many branches of learning, he never relaxed in his efforts to discover the Philosopher's Stone and the Elixir. He published a treatise, his *Libellus de Alchimia*, in which he gave copious instructions for the practice of the art, described apparatus and operations, and gave accounts of the origin and main properties of the chemical substances known to him. In short, he proved himself to be, under the limitations of his day, a man of genuine scientific spirit. A brief quotation from his *Libellus* reveals much. "I found many rich scholars, abbots, superiors, canons, physicians, and unlearned folk, who, in prosecuting this art, expended much time and labour, and who had to desist from lack of means." Of himself he says, "I did not despair, but expended

infinite labour and money." Clearly, the hold of alchemy on all sections of society was very strong, and the enthusiasm evoked was immense.

Aquinas.

The renowned scholastic, Aquinas, was a pupil of Albertus, and shared in the alchemic labours of his master. An amusing story concerning a living statue the pair were popularly supposed to have fashioned will be told when we come to treat more fully of the magic mingled with the practice of the Hermetic art. It is mentioned here only as proof of the closeness of the collaboration. In the famous *Summa*, when discussing adulteration, he determines that gold and silver made by alchemists, if it be true metal, may be sold; but if it have not the nature of the true metal, the transaction is fraudulent. That is to say, he knows there is fraud, but he also recognises that there may be successful transmutation. He also decides that the art is not unlawful if it be confined to the investigation of natural causes and effects, though some think it demoniacal (Pt. ii, 2, qu. lxxvii, art. ii). He here has in mind the distinction between white and black magic—the distinction that appeared in Ferguson's estimate of Michael Scott.

Roger Bacon (1214–1294).

Practically contemporary with the last named was Roger Bacon, undoubtedly one of the greatest men our nation has produced. His range of scientific

inquiries was wide; but alchemy was not the least favoured of his subjects. He devoted the third book of his *Compendium Philosophiæ* to the art, and it is one of the earliest authentic (some maintain, the earliest) European works that treat of it. He firmly believed in the Philosopher's Stone, and was unwearied in his efforts to discover it. He defines Alchemy as the science of the generation of things from elements. That is to say, he held that various kinds of substances can be built up out of simpler ones. This would seem to be much the same as our modern notion. If differs, however, in the use of the term "generation," which brings in the animistic element so characteristic of alchemical doctrine from first to last. The consideration of it is postponed to the chapter dealing with the alchemist philosophy. By the year 1267 he had spent more than 2000 libræ on secret books and in various experiments. That he was a true man of science is plain from the variety and number of his remarkable discoveries.* Had more of the adepts been animated by his spirit, and possessed his power of throwing off the shackles of tradition, modern science would have come more speedily to the birth. He was less fortunate than Gerbert and Albertus, and suffered much persecution and imprisonment. How far his alchemy was a provoking cause is hard to say.

Raymond Lully (1235–1315).

Less prominent on the science roll of honour, but higher on that of alchemy, comes the name of Raymond

* See p. 208.

Lully. His life was one exceptionally full of romance and adventure, and presented a most remarkable combination of fervour in religion and enthusiasm for knowledge. It was not until after middle age that he turned to the Hermetic art; but when once he had taken it up, he soon acquired great fame as an adept, and, as a writer on the occult sciences, earned the title of Doctor Illuminatus. He applied himself with ardour to the study of Arabian philosophy, chemistry, and medicine. It appears to be certain that he not only countenanced a popular belief in his power to make gold, but actually claimed it. It is said that, in response to an invitation from Edward I or Edward II, he came to London, where apartments were allotted to him in the Tower. The story goes that he replenished the royal coffers by transmuting iron, lead, pewter and quicksilver into gold. Some, however, maintain that the replenishing came through his advising a tax on wool!

The evidence for the English episode is disputable. But there is a specific statement in his last will which definitely proves that, at the time when the document was drawn up, he claimed to have put to use the grand secret. He therein asserts that he had converted no less than 50,000 pounds weight of base metals into gold.* This is very puzzling, especially as he had consistently shown himself to be free from most of the delusions of his day. It has been suggested that in his old age his mental powers were waning, and that he dreamt himself into the idea. Willingly we accord him the benefit of the doubt.

* "Converti una vice in aurum ad L millia pondo argenti vivi, plumbi, et stanni."

Arnold of Villanova (1245–1810).

A noted contemporary of Lully was Arnold of Villanova. He was probably a Spaniard; at any rate, he studied amongst the Arabs of Spain. He is said to have transmuted iron bars into gold at Rome. A paragraph from a treatise of his on "the grand operation," addressed to a pupil of his, will give a fair notion of the more fantastic elements in mediæval alchemy.

"Know, my son, that in this chapter I am going to teach you the preparation of the Philosopher's Stone. As the world was lost by the woman, so must it be by her re-established. For this reason, take the mother, place her with her eight sons on the bed; watch her; see that she makes a strict penitence until she is washed from all her sins. Then she will bring into the world a son who will sin. Signs have appeared in the sun and the moon; seize this son and chastise him in order that his pride may not destroy him. That done, replace him in his bed, and when you see him come to his senses again, seize him afresh to plunge him naked into cold water. Then put him a second time on his bed; and when he has recovered his senses, seize him afresh to deliver him to be crucified by the Jews. The Sun being thus crucified you will not see the moon, the veil of the temple will be rent, and there will be a great earthquake. Then is the time to employ a hot fire, and you will see raise itself a spirit concerning which everybody has been in error." *

* Quoted by Figuier, *L'Alchimie*, p. 42.

Anything less like the description of an experiment in a modern manual of chemistry it would be hard to conceive! Figuier remarks that Arnold himself seem to have no high estimate of the value of this exposition. For when the pupil exclaims, "Master, I do not understand," the master promises to be more clear another time. The interpretation would indeed be hard to find. Certain terms will gain a meaning when we come to consider alchemist phraseology, such as the sun for gold, the moon for silver, and so forth. But the general tenour and spirit of the exposition belong to another world than ours.

Universal Diffusion.

It will now be apparent how firm was the hold that the art had got in Christendom at large. The conviction had seized on society that the Philosopher's Stone was a known substance, and that its secret might be discovered by any one. The contagion of example fanned these high hopes to a flame. Reason was compelled to play a subsidiary rôle; emotion blinded and led it captive.

Its spell was on all ranks, from the monarch to the peasant. A Pope himself, John XXII was an ardent alchemist. He was careful, indeed, to pronounce censures on black magic; but he had his own laboratory at Avignon, where he conducted experiments in person. He was said to have left behind him 25 million florins—a thing quite possible, though the source of the wealth has to be sought elsewhere than in transmutation! Nor was the highest royal

patronage lacking. The Emperor Rudolph II, for example, earned the title of "the Hermes of Germany," from the fame of his laboratory at Prague, where there was open welcome for all adepts who cared to use it. Almost every court in Europe had its alchemist, to whom were accorded, as has been said, "the privileges of the court fool or the poet laureate." And at the other end of the social scale, many a peasant's cottage had its smoking furnace and its modest store of stills and crucibles. In the sixteenth century the art became almost a religion—so earnest was the study devoted to it, so intense the feeling it stimulated. Indeed, the knowledge of the secret, many declared, could only come by the grace of God —by a special inspiration. One adept thus addresses the operator: "Now thank God, Who has granted you so many favours as to lead your work to this point of perfection. Pray to Him to guide you, and to keep your precipitation from bringing about the loss of a labour which has come to a state so perfect." Another adept, after an experiment, breaks forth into a doxology, long and fervent, such as might conclude a devotional manual. It is quite common, in technical treatises, to meet with injunctions that no operation should be undertaken without prayer for its success.

Mediæval Criticism.

There was, however, another side to all this. We remember how Geber had confessed to grave doubts about the accomplishing of transmutation. So, in the Mediæval period, there were some who were

sufficiently detached to become critics of the art. One line of criticism was theological—alluded to, as we saw, by Aquinas in his *Summa*. The attempt to transmute, it was urged, is impious; it presumes on the prerogatives of the Creator. Parallel arguments are not unknown in the present day, as in the case of inquiry into spiritualistic phenomena. They are based on a perverted sense of reverence. As Aquinas decided, so we, too, may regard all avenues to knowledge of nature to be open, provided, of course, that no moral principles are transgressed.

Another line of criticism was suggested by the enormous amount of knavery which accompanied and tainted the development of the art. We find it quaintly, but strongly, stated in Chaucer's *Canon's Yeoman's Tale*. We find it in Dante. From the arch of the tenth chasm he sees alchemists he had known suffering among Falsifiers of every sort. He regards them as falsifiers in things, in distinction from falsifiers in deeds and words. Griffolino of Arezzo tells him that "for the alchemy I practised in the world, Minos, who may not err, condemned me." Capocchio, a Florentine, laments, "so shalt thou see that I am the shadow of Capocchio who falsified the metals by alchemy. And thou must recollect, if I rightly recognise thee, how well I aped nature." Adam of Brescia is accused by Sinon—"If I spoke false, thou too didst falsify the coin." * The poet in these passages speaks of defrauders of whom he had actual knowledge, and who misused the art. He does not imply, however, that the art itself was spurious. It is even argued by some that the phrase,

* Dante, *Inferno*, Canto xxix. 118–139; xxx, 115.

"How well I aped nature," implies its impiety rather than its misuse; but the whole context negatives such an interpretation.

A third line of criticism was more legitimate than the first, and more fundamental than the second. It may be called scientific. It questioned the possibility of transmutation. Not many ventured to advance it in the times when tradition held a sway so imperious; still it made its appearance here and there. For example, Peter the Good of Lombardy, a physician, in 1330 wrote a treatise on Chemistry—*Margarita preciosa* (a name for the Stone), in which he used scholastic arguments to disprove the alchemist assumption. Here is one of his syllogisms.* "No substance can be transformed into another kind unless it be first reduced to its elements. Now alchemy does not proceed thus. Therefore it is an imaginary science." Again, "Natural gold and silver are not the same as artificial gold and silver. Therefore," etc. This criticism is deprived of much of its weight (such as it is) when we find its author asserting that he can with equal ease prove that alchemy is a sound science! Still, it raised the issue.

Persecution.

There was also a practical side to the effects produced by constant failures. Kings and rulers who patronised alchemists looked for tangible results. How fared it, then, with adepts who disappointed them? Some saved themselves by plausible explanations—some by flight. Not a few suffered

* Quoted by Figuier, *L'Alchimie*, p. 87.

severe punishments, or perished by untoward fates. Honest professors who failed came off no better than deceivers and rogues—it was the fact of failure that really mattered. It was thus that a female adept, Marie Ziglerin, was burnt by Duke Julius of Brunswick in 1575. David Benther killed himself to avoid the anger of the Elector Augustus of Saxony. Bragadino was hanged at Munich in 1590 by the Elector of Bavaria. William de Krohnemann was hanged by the Margrave of Beyreuth, who, with grim irony, had this inscription posted on his gibbet: "I once knew how to fix mercury, and now I am myself fixed." Some were invited to courts, and then imprisoned until they fulfilled their promises. The device became so common that wise alchemists learnt to avoid even the most flattering invitations. Thus strangely were intermingled tragedy and comedy —naïve fanaticism and gross fraud. Mediæval alchemy was in harmony with the spirit of its time.

CHAPTER IV

DECADENCE

WITH the passage of years, alchemy multiplied its aims, its doctrines, and its operations. Had it been a genuine science, increasing complexity would have been all to the good. It would have provided materials for further advance. But it was essentially chimerical; its avowed objects were unattainable. Hence came a parting of the ways. On the one hand, men of careful, sober thought sifted out the true from the false, made it the starting-point for further experiments, and laid the foundation of a real science of chemistry. On the other hand, less balanced minds, visionaries and quacks abandoned themselves to ever-wilder absurdities, and wandered further and further away from the world of facts. As a consequence, the art was overwhelmed with a burden of monstrosities too heavy for even the foolishly credulous to bear. And thus the acme of the popularity of the art was followed by a period of decadence which ended in a total discrediting of its claims.

This period of decadence lasted until well into the eighteenth century, and in its later stages was contemporary with that general advance in knowledge of nature which ushered in the triumphs of modern

science. Steady lights were coming into view which guided earnest students out of the quagmires of fantasy and rescued them from the irresponsible pranks of will-o'-the-wisps.

Medical Alchemy.

Perhaps the most characteristic feature of the decadent period was the extension of the powers attributed to the Philosopher's Stone. Hitherto the main, though not the only, object had been the transmutation of metals. Attention is now fixed rather on the medical, moral, and even spiritual virtues of the wonder-worker. Alchemists became professed healers of bodily and mental sickness or disease. The new development was based on the idea that vital processes were chemical in their nature. If anything went wrong, then, with a living organism, there was need of a chemical remedy. Not that the hope of transmutation was abandoned. With the more sober-minded alchemists it remained the one great aim; and even with the visionaries and reactionaries, it was merely subordinated to the gaining of health, prolonged life, and happiness, by alchemical means. Concurrent with growth of the new tendency there was a startling increase of nebulous mysticism, superstition, and trickery.

When once the idea of chemical remedies had taken root, it naturally led to the making of many experiments. It is fearful to contemplate what poor mortals had to suffer at the hands of practitioner adepts! We had a very faint reflection of it in fairly recent days, when drugs were fashionable, and patients were

dosed without regard for other and sounder methods of healing. Nevertheless, in so far as the experiments were reasonably conducted, the results of medical alchemy were often profitable both for chemistry and for medicine.

Paracelsus (1493–1541).

The active originator of the new development was the man whom Naudé calls "the zenith and sum of all alchemists," the renowned Paracelsus. How far he was an adapter of existing tendencies, and how far an innovator in his own right, is uncertain. But in any case his influence was enormous, widely extended, and persistent. Some knowledge of his career and of his teaching is essential to the understanding of what is to follow.

He was the son of a physician, and was himself educated for his father's profession, though it would seem without much care or thoroughness. While still a student, he came under the spell of alchemy, and was deeply smitten by the lure of the Philosopher's Stone. With a view to acquiring knowledge that might aid him in the quest, he set out on an extended series of travels. He gained his living by very varied means—telling fortunes, professing magic powers, selling quack medicines, acting as army surgeon, and many other activities reputable or the reverse. When at length he settled down, the diversity of his pursuits was no less remarkable. As one biographer puts it, "he was at once adept and wizard, sceptic and critic." The most noteworthy acquisition he had gained was an acquaintance with metallic chemistry, by which he

was said to have cured thirteen princes whose cases had been declared hopeless. His fame rapidly increased, and in 1526 he was appointed professor of Medicine and Natural Philosophy at Basle. At the end of two years he was ejected on a charge of quackery. He led a life of unbridled intemperance, became a hopeless sot, took again to travelling, and died at the age of forty-eight in a condition of abject poverty.

His glaring faults and weaknesses, his vanity and effrontery, his intemperance and quackery, have led many to condemn him as a worthless charlatan. Perchance he was not so bad as he was painted; for he had the hardihood to attack with unsparing vehemence the medical traditions of the time; and we may be sure that his reputation would not gain by venturing on such a course! Still, there can be little doubt that he gave the enemy ample cause to blaspheme. And yet Lavater declared him to be "a prodigious genius." The *Encyclopædia Britannica* calls him "the pioneer of modern chemists and the prophet of a revolution in science." Browning chooses him to be the subject of one of his most ambitious poems, not extenuating aught, but recognising in him elements of a noble strain and of true greatness. It is assuredly necessary that a man who can give grounds for such encomiums should be cleared of the prejudiced and superficial judgments which have so long obscured his exceptional gifts and solid merits.

Take as an example of misunderstanding, or misrepresenting, a practice adopted by Paracelsus. It is recorded of him that he had a jewel in which he kept

imprisoned a spirit who was at his command. In some of the old portraits he is represented with this jewel in his hand, and on it inscribed the word "Azoth," the name he gave to it. Now, as Browning remarks in the notes at the end of his poem, this Azoth was simply *laudanum suum*—one of his most notable discoveries. It is possible, nay, probable, that he fostered the popular delusions concerning the nature and powers of his potent drug—but the fact remains that he knew it and used it. Who shall estimate what it has accomplished as a remedy and as an alleviator of human suffering?

As to his personal character, there are at least two traits which stand to his credit. He must have been loved and respected by his pupils. For they call him their "noble and beloved monarch," "the German Hermes," and "our dear Preceptor and King of Arts." And his epitaph records of him that he was generous to the poor. From another source we find that he often dispensed medicines and gave personal attendance free of charge to those who could not afford to pay him.

The works that can be critically attributed to him are full of turgid, incoherent writing. The obscurities necessarily incident to describing non-existent substances and imaginary powers were in his case exaggerated by the inflamed condition of his brain. But one thing is certain. He is in rebellion against the medical system of the school of Galen. He is unsparing in his diatribes—his language is unrestrained in its vigour. And although we may be repelled by his coarseness and self-assertion, we must allow that he initiated a great reform. He burst through

the fetters with which the centuries of tradition had strangled progress in chemistry and medicine. His alchemy, even, was of a new type. He maintained that it should aim, not so much at the making of gold, as at the furthering of healing and the arts; and he was ever ready to make direct appeal to nature in place of searching for authorities in the works of those who had written about nature with but small knowledge of her ways.

Violent as was his rebellion against the received systems, he could not, of course, rid himself completely of their influence. Indeed, in many respects he strengthened prevailing superstitions, and started fresh ones. How deeply he erred in such matters is evidenced by the fact that the Rosicrucians claimed him as one of their greatest founders. Even his medical chemistry is adulterated with old and new absurdities. For instance, he connects potable gold with the Elixir of Life. He held that ossification of the heart and all manner of diseases could thus be cured, provided that the gold had been obtained by transmutation. He is here leaning on certain astrological analogies derived from the past, and from the same source he borrowed his idea that medicines should be administered at particular conjunctions of the planets.

One of his doctrines will be judged by most to be bizarre. He taught that in the stomach of every human being there dwells a spirit who is a sort of alchemist, mixing in due proportions the various foods that are brought together in that living laboratory. Is this really so far removed from the teaching of many modern authorities? Driesch, for example,

has his "entelechy," the unknown unifying agent in an organism which guides and controls the physical and chemical processes that build and sustain its life. Perhaps in this case also Paracelsus was a prophet!

At any rate Paracelsus chose the nobler side of alchemy—medicine. It was also the more difficult. Bacon has a judicious comment on this subject. "Man's body (he writes) is of all things in nature most susceptible of remedy; but then that remedy is most susceptible of error. For the same subtlety and variety of the subject, as it supplies abundant means of healing, so it involves great facility of failing. And therefore as this art (especially as we now have it) must be reckoned as one of the most conjectural, so the inquiry of it must be accounted one of the most exact and difficult." It was in this exactness that Paracelsus failed. He was rash, headstrong, prone to fancies and mystical follies. Hence it is that Bacon repudiates him. "Not that I share (he proceeds) the idle notion of Paracelsus and the alchemists, that there are to be found in man's body certain correspondences and parallels which have respect to all the species (as stars, planets, minerals) which are extant in the universe: foolishly and stupidly misapplying the ancient emblem (that man was a *microcosm* or epitome of the world) to the support of this fancy of theirs." * Bacon is right. Nevertheless even errors such as these had their share in bringing in a better system, because they served to break down the prestige of tradition.

Another aspect of Paracelsian healing has an oddly

* *De Augmentis Scientiarum*, chap. ii.

modern look. It anticipates Christian Science, by emphasising the power of mind on body. "Fascination (says Bacon) is the power and act of imagination upon the body of another; wherein the school of Paracelsus and the disciples of pretended natural magic have been so intemperate, that they have exalted the power of the imagination to be much one with the power of miracle-working faith." * Paracelsus wrote a special tract upon this subject, *De Vi imaginativa;* and mentions it in many other parts of his writings. Here also he was a prophet!

Once again, he anticipated organic chemistry. Bacon mentions, to condemn, his notion that "in bread and meat lie eye, nose, brain, liver;" and that "Archæus, the internal artist, educes out of food by separation and rejection the several members and parts of our body." † Here Paracelsus is after all nearer to the truth than his critic. For it is now established that the nitrogenised components of animal bodies are derived from the corresponding elements of their food. There is separation and also transformation of the materials. It is remarkable at how many points this irresponsible speculator touches on modern discoveries. He was verily a genius. How tragically his powers were wasted!

Successors of Paracelsus.

So much for the great master. What of his disciples and successors? Healthy development was slow and

* *De Augmentis Scientiarum*, chap. iii.
† *Novum Organon*, 2nd Book of Aphorism, xlviii.

laborious. The store of physical and chemical knowledge was still too scanty to enable even strong and steady thinkers to avoid entangling errors. The unbalanced minds seized on all the worst elements in the new doctrine, exaggerated them, and gloried in absurdities. For example, Paracelsus taught, as we just now saw, that digestive processes were accomplished by a subtle alchemy—that they were vital transmutations. Certain of his followers improved on this. They held that everything—metals and material substances of all kinds, as well as animals and men—digests, eats, drinks, assimilates, rejects. Or again, the master had taught that a spirit presides over these digestive processes. His followers improved on this idea also. They multiplied the spirits until they had corresponded in number with all the manifold workings of nature. Sylphs inhabit the air, nymphs the water, pigmies the earth, salamanders the fire. In medicine, rashly responding to a rashly given lead, they wrought untold harm by employing, without skill or knowledge, strong metallic poisons. And, like their master, they provoked by their irrational zeal reactions that seriously retarded much-needed reforms. Nevertheless they were breaking up the cake of custom and tradition. In this strangely mixed world, even fanatics have their function. It is sometimes wise to suffer fools gladly—within measure!

In cheering contrast was the progressive work of calm and acute intellects who carried on inquiries into the scientific value of the new teaching. It was these wiser disciples who have secured for Paracelsus those striking encomiums; for they seized upon and

developed what was best in him. It was thus that there came the fateful parting of the ways. The very length to which the visionaries went had a steadying effect on those who were not carried away by their mysticism and occult speculations.

The Rosicrucians.

A famous, romantic, and altogether extraordinary development of the irresponsible alchemy was that known as the secret brotherhood of the Rosicrucians. This society contrived to surround itself with so much mystery that popular imagination had free scope in guessing at what it was, and what it was able to do. As a consequence extravagant stories got afloat; and the excitement they caused was artfully fostered and maintained by the issue of books purporting to come from authorised members of the fraternity, as also by dramatic advertising of their powers and their intentions.

It is not even certain that such a society existed at all; for it had not any known meeting-place, nor was there a recognised roll of membership, though various individuals professed more or less definite adhesion to its professed principles. At any rate, those who represented it by their publications repudiated any other derivation of its name than that which referred it back to the reputed founder, Rosenkreutz. This man certainly had a career which fitted him to play the rôle assigned to him. Born in 1378, educated in a monastery, he fell into the hands of certain magicians when he was but sixteen years old, was initiated for five years into their secrets, travelled in

Turkey, Palestine, and Syria, conferred with Arabian sages, visited Spain, and at last, fully illuminated, returned to his own country. He shut himself up in a cave, and lived in solitude to the age of a hundred and six years, always in full health, and exempt from infirmities. There, in 1484, God took his spirit from him; his body remained in the cave, which thus became his tomb. After "six times twenty years" it was marvellously rediscovered, and all manner of mystic and magical things were found there. It was in the year of this reputed miracle, 1604, that the Rosicrucian confraternity took its rise. This legend is abbreviated from Figuier's account; and Figuier took it from a Rosicrucian manifesto published in 1615. It admirably illustrates the spirit which animated the society.

It was claimed, then, that Rosenkreutz founded the society in 1459, with the ordinance that its existence should be kept a profound secret for 200 years. Thus were refuted those who connected the name with the sign or emblem of a "Rosie Cross"; and those also who derived it from *ros*, "dew" (held to be a powerful dissolvent of gold), and *crux*, "cross" (which, in chemical symbolism signifies "light"). The latter of these repudiated origins, at any rate, is in harmony with the view supported by many that the Philosopher's Stone was to be sought by the intervention of dew and light.

In an anonymous pamphlet, issued in 1614, the members are declared to be possessed of fabulous scientific knowledge, and to be absolutely free from illness, disease, and suffering. In 1622 the Society put out the following manifesto: "We, deputed by

our college . . . make our abode, visible and invisible, in this city . . . each without books or notes. and speak the language of the country wherever we are, to draw men, like ourselves, from the error of death." The word "invisible" refers to the fact already mentioned, that the Society had no settled centre, nor visible government; and its members were supposed to have the gift of being unseen and unknown—thereby in no small measure increasing the excitement when they proclaimed that they were about to visit any city.

This late development of the Hermetic art sought to give prestige to its fantastic doctrines by assigning as authorities spurious treatises attributed to Hermes, Aristotle, and other of the ancients, as well as those attributed to Albertus Magnus, Paracelsus, and other moderns. Gradually the name Rosicrucian came to be used generally for any kind of occult pretension. The Stone continued to be the great centre of mystery. It was supposed to give command over elemental spirits, enable men to defy limitations of space, time, and matter, afford intimate knowledge of the arcana of the universe. This farrago of nonsense was expressed through a welter of symbols and metaphors—red bridegrooms and lily brides, green dragons and ruby lions, royal baths and waters of life. At last such extravagances overshot the mark, and sealed the fate, not only of the Brotherhood, but of the art. All that one can say is that the sylphs, pigmies, gnomes, salamanders, and the rest, ousted the cruel demonology of the Middle Ages—incubi, succubi, demons, and other horrors that had terrified Christendom—and so far made the world a happier place to live in.

Addison has a charming Essay on "Contentment." * He opens it by telling us he was once engaged in discourse with a Rosicrucian about the great secret. "As this kind of men (I mean those of them who are not professed cheats) are over-run with enthusiasm and philosophy, it was very amusing to hear this religious adept descanting upon his pretended discovery." Then follows an account which is much to our present purpose, because it summarises the leading ideas of the Society. "He talked of the Secret as of a Spirit which lived within an emerald, and converted everything that was near it to the highest perfection that it was capable of. 'It gives a lustre,' says he, 'to the sun, and water to the diamond. It irradiates every metal, and enriches lead with all the properties of gold. It heightens smoke into flame, and light into glory.' He further added, 'that a single ray of it dissipates pain and care and melancholy from the person on whom it falls. In short,' says he, 'its presence naturally changes every place into a kind of heaven.' After he had gone on for some time in this unintelligible cant, I found that he jumbled natural and moral ideas together into the same discourse, and that his great secret was nothing else but content."

The Chief Cause of Decadence.

Addison hits on the gravest fault of alchemy, "the jumble of natural and moral ideas"—or in more general statement, the confusion of objective facts and

* No. 574, July 30th, 1714.

subjective notions. This fault was from the first a marked characteristic of alchemy; but came to a head in this closing period of its long career. Adepts read themselves into their experiments, instead of patiently observing what nature had to teach them. No true science could develop so long as research was conducted on so fatuous a method. And when true science did at length lift up its head, subjective alchemy was doomed. The hope of transmutation did not, however, disappear. It survived the art which had fostered it, and engaged the minds of such men as Ashmole and Newton—but only by way of sober experiment. Indeed, it is even yet to be reckoned among those which may engage the highest activities of the science of the future.

CHAPTER V

TRANSITION TO SCIENCE

THE old alchemy and the new chemistry—how great the gap between them! They seem to belong to different worlds. True. And yet the incidents treated of in the last chapter will have prepared us to recognise that, wide as is the difference, there was nevertheless continuity. This continuity was not that which characterises the growth of an individual plant, as Thorpe observes, unbroken in every detail; but rather that which links parent and child—a living bond, but an independent existence. If we trace the steps by which the change has come about we shall find that the new science did not cut itself off at a stroke, any more than a child is straightway self-sufficient. The central idea of transmutation long retained its hold, and only yielded to the growing pressure of facts slowly but surely accumulated by careful experiment.

It would be artificial to assign a date for the beginning of the transition period. It ran its course concurrently with the decadence of alchemy, and was well on its way in the middle of the seventeenth century. Its close may be put at the beginning of the nineteenth century, when alchemy was finally discredited and modern chemistry set on a firm footing.

The essential difference between the old and the new may be conveniently paralleled by that between Paracelsus, the representative of the mystical development, and Robert Boyle, a splendid example of the alchemist merged in the scientist.

Robert Boyle (1626–1691).

Paracelsus died about 1540. Robert Boyle was born in 1626. Hardly a century intervenes. And yet the contrast in the environments, the characters, and the aims of the two pioneers is most striking. The early education of Paracelsus had been neglected. Boyle was sent by his father, the first Earl of Cork, to Eton. Paracelsus set out on almost vagabond travels. Boyle spent six fruitful years on the Continent, accompanied by a tutor. Paracelsus from first to last was violent, ungoverned, chaotic. Boyle from first to last was studious, gentle, restrained. On returning from his travels, Paracelsus hurried on from one turbulent experience to another, never at rest. Boyle settled quietly down at his home and at Oxford. Both men cultivated the sciences, more especially chemistry. But whereas Paracelsus buried what was good in his reforms under a load of incoherency and charlatanry, Boyle manifested the cautious critical temper that gave sustained purpose to his labours and advanced the cause of systematic research. Just as diverse in aim, method, and spirit were the old alchemy and the newly-born chemistry. And yet, as was before stated, they were in the relation of parent and child.

Equally striking was the difference in the outcome of their labours. The Paracelsian tradition found its most congenial expression in the Rosicrucian brotherhood. Boyle was one of the first members of an association of scientists which, after holding private meetings, was incorporated in 1663 as the Royal Society. He was offered the presidency, but his modesty and retiring disposition made him decline the honour. It is strange to think that the rise of these two so dissimilar societies was practically contemporaneous!

We naturally ask how far Boyle accepted the current doctrines of the Hermetic art. He certainly did not deny the possibility of transmutation. He was far too cautious to commit himself on a point so crucial when the evidence for and against was so scanty and imperfect. He went to work to collect facts and observations, and to clear away false notions; and was thus led to doubt the explanations on which the alchemists relied. He was specially anxious that account should be taken of the part played by the air in their calcining experiments, and thus brought into prominence the problem of combustion. It was the solution of this problem that ultimately subverted the old doctrine of the elements, and prepared the way for the discovery of the really "fixed" elements, in the sense now accepted. He has been called the true precursor of the modern chemist. Paracelsus was an eruptive force. Boyle was a patient investigator. Each heralded advances, but Boyle's career was more evenly in line with the onward march of truth.

Alchemy at Oxford.

An interesting episode in the history of the art during this period was the establishing of an alchemical centre at Oxford. Boyle there organised a famous chemistry class. A famous Rosicrucian chemist was brought over from Strasburg; Lock and Christopher Wren were among the pupils. Elias Ashmole joined in the venture and provided for its continuance. He agreed that he would hand over to the University his many treasures, artistic, antiquarian, and scientific, on condition that a fitting museum was built, the lowest room of which was to be a well-fitted laboratory. Ashmole was perhaps the last of these Oxford alchemists. His treatise, *Theatrum Chemicum Britannicum*, published in 1652, contains many extracts from old Hermetic philosophers, while at the same time it places the study of chemistry on a sound footing. No less a person than Sir Isaac Newton collaborated with him for a time in the investigation of the transmutation doctrine, including the question of the existence of some transmuting material, Philosopher's Stone or other. We may regard Ashmole and Newton as eminent examples of the class of scientists who gave alchemy a fair trial, and who reluctantly abandoned the hopes it had stimulated.

The gradual undermining of belief in the principles of alchemy, on their scientific side, was mainly the result of research and experiment. But it was in no small degree accelerated by the unmasking of fraudulent pretenders. Even the most credulous could not avoid being influenced by the atmosphere of

suspicion which had inevitably gathered round the art. The collapse, however, came suddenly, at any rate in England and Germany, as the result of two fiascoes—one tragic, and one comic.

Critics.

The gradual undermining of belief in the principles of alchemy went on apace. A series of critics dealt it doughty blows; and the whole trend of careful experiment was adverse to the old claims. John Kunkel (1630–1702), the son of an alchemist, condemned the lack of precision in the terminology of the art, and repudiated Van Helmont's teaching about the alcahest as "all a lie." He himself adopted the experimental method, and made many valuable discoveries. Nicolas Lemery (1645–1715) wrote one of the best text-books of his time, *Cours de Chimie*. Defining his aims, he writes thus: "The fine imaginations of other philosophers concerning their physical principles may elevate the spirit by their grand ideas, but they prove nothing demonstratively. And as chemistry is a science of observation, it can only be based on what is palpable and demonstrative." *

Hermann Boerhaave (1668–1738), one of the most learned men of his day, was the author of a valuable treatise on chemistry, in which he traced the development of the art, as well as expounded its principles. As regards alchemy, he was an agnostic. On the one hand, he would not venture to set bounds to the possible in nature; on the other hand, he could not yield assent. So, like Boyle and Newton, he was content to

* Quoted by Thorpe, *History of Chemistry*, vol. i, p. 64.

suspend his judgment until further evidence was available. In the light of our present knowledge, this hesitation may appear excessive. But if we think ourselves back into those days, we shall acknowledge that his expectant attitude was thoroughly scientific. And we shall be all the more sympathetic when we realise that the whole problem of the constitution of matter is again an open one, though some of the old beaten paths have been closed.

Scientifically, the reign of alchemy came to an end with the new theories of combustion. As our subject is alchemy, we need not enter into detail concerning the development of experimental physics and chemistry. There are a multitude of works which cover this ground. Let it suffice to say that the "elements" of the Hermetic art were replaced by the "elements" of the modern chemist. The old art was doomed.

Dr. Price.

"Scientifically," alchemy came to an end with the emergence of new views of matter; experiment gradually supplied explicit refutations of it. It was otherwise with what we may distinguish as the emotional spell of the art, and the popular belief in the claims made by adepts. Here it was rather the dramatic unmasking of illusions or frauds that ruptured the uncritical hopes of success. In England the *coup de grâce* was given by the tragic case of Dr. Price, of Guildford, which shall be briefly related.

He was a wealthy and learned man, and wrote some interesting works on chemistry. In 1781 he

imagined that he had succeeded in compounding a powder which would change mercury or silver into gold. At first he confided his secret to a few friends, and had no thought of publicity. But the rumour of his discovery got abroad, and emboldened him to come out into the open. He went so far as to give public exhibitions of his transmutations, and even invited a distinguished company to his laboratory to see a series of experiments calculated to produce conviction. Waxing yet more bold, he printed an account of these proceedings, and induced eminent persons to give their signatures as witnesses to the truth of his statements.

It is startling to realise that such pretensions were seriously advanced within twenty years of the coming in of the nineteenth century! The fact affords a striking proof both of the persistence of the idea of transmutation, and of the slowness with which the new views of matter matured. We must not think, however, that Price's statements were universally accepted, or that they were unchallenged. The undermining had gone too far for that! Unfortunately for the belated alchemist, though fortunately for the cause of truth, it happened that the Royal Society was concerned. Price was a member. The Society conceived its honour to be at stake, and summoned him to appear before a duly qualified committee, in order that the claim might be submitted for an authoritative judgment. Price refused to be thus tested. He excused himself on the plea that the stock of his transmuting powder was exhausted, and that its replenishment would be a long and arduous undertaking. Under further pressure, he sought

to escape by professing that he was a Rosicrucian, and therefore not permitted to divulge the secret. These pretexts were of no avail—the Society was insistent, granted him time, but demanded a test. In 1783 he returned to Guildford to prepare the powder. Six months passed and nothing was heard of him. The Society then fixed a date on which he should fulfil his engagement. He invited the Society to Guildford. Only three members responded. He received them, and then committed suicide in their presence.

Thus tragically ended the career of England's last public alchemist. Up to what point was Price really deluded? When and why did he enter on a course of systematic deception? These questions cannot be answered. Nor can even the prior puzzle be solved, how, supposing him to have been originally really convinced that he had gained the secret, he had arrived at such a conclusion. At any rate, the Royal Society was amply justified in its determination to investigate. And the dramatic features of the failure, brought so prominently into notice, completed in this country the overthrow of an already discredited art.

SEMLER.

Singularly enough, at about the same time a similar failure led to the final rejection of the art in Germany, though the attendant circumstances were in the region, not of tragedy, but of comedy. There was at Halle a certain professor of theology, Semler by name, who had been strongly attracted by the literature and practice of the Hermetic art. His own labours were

without success. But he took up warmly a discovery made by Baron Leopold de Hirschen—to wit, a marvellous Salt of Life. He asserted that this salt was not only a transmuting substance but also a universal medicine. No elaborate process was necessary for the production of gold; it sufficed to dissolve it in water and to leave it for some days in a glass vessel at a uniform temperature. Semler obtained some of this, and was surprised to find gold in the crucible. Another chemist, Klaproth, analysed the "Salt of Life," and found it to consist of Glauber's salt and sulphate of magnesia. There was also, however, some gold! It was evident to Klaproth that particles of gold had been from the first in the liquid to be proved, and that the addition of the salt was a work of supererogation. Semler was perturbed, and sent a second supply of the liquid and the salt, and the analyser went to work again—this time in the presence of a large company. Semler's position as a professor demanded respect, even though scepticism bordered on ironic denial. He solemnly assured those taking part in the experiment that he himself had never once failed to obtain a successful result. So the testing proceeded. And lo! instead of gold, Klaproth found a kind of brass called tombac! The joke spread from the room throughout the country. The explanation of the fiasco put an edge on it. It appeared that Semler had a servant who was much attached to him. To this man was entrusted the task of feeding the fire and attending to the apparatus. He saw how eager his master was to find gold in the crucible, and being anxious to please him, purchased some gold-leaf and put it into the mixture. Being

called away on military service, he entrusted the task to his wife, The good woman saved the situation by purchasing brass instead of gold, and poor Semler became a laughing stock. This was better, however, than being a disseminator of a falsity which might have given a longer lease of life to a mischievous delusion. Of course every one acknowledged the professor's perfect honesty. He resumed the safer part of his duties at the University. But the art he would fain have fostered was discredited—laughed out of court. The general public in Germany, as in England, at last concluded that the Philosopher's Stone and the Elixir were, even if possible, beyond human reach.

The End of Alchemy.

As a recognised pursuit alchemy came to an end at the close of the eighteenth century. What remained were merely flickerings of an extinguished fire. In Germany, a society for alchemical research existed as late as 1819. In France, Chevreul, who lived well into the nineteenth century, records that he knew of several persons who were convinced of the truth of the art, among them being "generals, doctors, and ecclesiastics." Benighted dreamers there may even yet be who dabble in the forgotten lore. But the transmutation idea, in its old form, is a thing of the past, and can never be resuscitated. A new physics and a new chemistry have made clear the futility of its traditional doctrines and methods, though they have also, under wondrously changed conditions, rekindled the hope they had extinguished. But let us not forget that the old provided a basis for the new.

As George Eliot has put it: "Doubtless a vigorous error vigorously pursued has kept the embryos of truth a-breathing: the quest of gold being at the same time a questioning of substances, the body of Chemistry is prepared for its soul, and Lavoisier is born." *

Such, in outline, is the history of the Hermetic art. It covered a long period, travelling down from the Alexandrine mystic to the modern scientist. We can now enter on the study in fuller detail without a rigorous adherence to chronological order. We can treat separately of doctrines, practices, notions, orientating ourselves from time to time by referring to the chequered story of origin, development, and decay.

* *Middlemarch*, chap. xlviii.

PART II

THE IDEA OF TRANSMUTATION

CHAPTER I

SUGGESTIONS FROM NATURAL PROCESSES

LET us begin our more detailed study by making sure that we understand the alchemist's idea of transmutation, and the external phenomena which suggested it. To assume that he occupied our own standpoint, and to criticise accordingly, is to miss entirely the whole significance of the story. Between him and the modern scientist intervenes a tremendous revolution in physical and chemical conceptions of the nature of matter. The advance is hardly yet a century old, but is of fundamental and deep importance. It alters our whole outlook on the universe.

Brought up, as we are, in an atmosphere pulsing with the conceptions characteristic of the new physics and the new chemistry, it requires an effort if we are to think ourselves back into the old order. The very language of the alchemists is strange to us. But the effort is well worth the while. For we shall the better appreciate our conquests if we know something of how they were won; we shall enter more thoroughly into their purport if we study the errors which were overthrown.

Can the fundamental difference between the old and the new be briefly stated in a preliminary fashion? Perhaps the simplest way of doing this is to define

roughly what was the alchemist's idea of the behaviour of matter. He, and many of us, are thus far on common ground, that we agree in assuming a primary kind of matter out of which all the different substances in the world are formed. The gap between us yawns when we proceed to ask how the primary substance comes to manifest forms so diversified. The modern scientist holds that the cosmic process has brought into being certain forms of atoms which are, relatively to our power of dealing with them, fixed and unchangeable. At present more than eighty different kinds are recognised. It is not, of course, denied that further discoveries may diminish or increase this number. But the principle involved is firmly adhered to.

Quite other was the alchemist's assumption. He held that all the different kinds of substances are "fluid," so to say, and pass naturally from one form to another. Each kind he conceived to be actively striving to develop, or grow, into a nobler state. And his art aimed at hastening, by special means, what is essentially a natural process. The points thus raised will be discussed in due course. But with the sharply drawn distinction in our minds, let us ask how the alchemist came to embrace the doctrine that governed for so long a time his speculation and his practice.

A World of Change.

On the grand scale and on the small, the universe manifests all-pervading and unceasing change. And the more closely nature's ways are examined, the more

clearly emerges this fundamental fact. Moreover, many of these changes have the appearance of being transmutations. Take a few simple examples germane to our subject. Water evaporates; vapour condenses into water. The fuel on the fire disappears in gases and smoke, leaving but a dead ash; the dead ash, in turn, may go to the building up of living plants and animals. Foods are taken, and form flesh and blood; the body decays and returns to the dust from which it sprang. So compelling is the evidence that it suggested the first philosophical systems of the Greeks, and is thus fundamental to all the subsequent philosophy of the Western nations. One of these early thinkers, Heracleitus, concluded that existence is an eternal "flux." He likens it to the flow of the water in a river; the current moves on ever; so that a man can never really step twice into the same stream. Add to this conception the idea of change in form and appearance, and we have the world viewed as a series of transmutations.

The Alchemist's Aim.

Alchemists busied themselves with metallurgy and practical chemistry. They therefore applied this reasoning with special reference to their art. Their experiences were largely of a kind to illustrate and enforce it, gathered as they were from striking changes wrought by chemical reactions, and by fire. Fire not only melts substances, but often metamorphoses them. Mercury can be heated so that it becomes a bright red powder—colour, mobility, gleam, all vanish,

to give place to a substance with almost opposite qualities. What were they to conclude? They knew nothing of the part played by the oxygen of the air: the discovery of that was the result of long and laborious experiment in quite recent times. Fire alone seemed to have effected the startling transmutation. And if so, could not the same agent, or other operations, bring about the seemingly far simpler change of tin into silver, or of brass into gold? Such a line of argument was natural. We know that as a matter of fact it was followed, and that it led to conclusions which, though erroneous, were reasoned.

We must therefore allow that, under the conditions then prevailing, the inference from observations of external happenings to the possibility of transmutation was warranted. Indeed, the supposition may be granted the rank of "scientific." That in the long run it proved to be a mistake does not deprive it of the claim. Otherwise there will be little of our up-to-date science which on like grounds may not ultimately be degraded!

The Quality of Colour.

The early alchemists were in possession of a large number of receipts for making alloys that imitated the precious metals. Their problem was, not to imitate, but to transmute; not to make the baser metals simply "look like" gold or silver, but actually to change them into the real thing. This meant, of course, that the qualities in which the differences consisted must be modified.

The first of the qualities to receive attention was that of colour. The Alexandrian adepts conceived it to depend on a process of dyeing. But we must be careful to understand what the genuine alchemist meant by "dyeing." We ourselves think of a dye as a colouring matter which imparts a particular hue to a material, but does not become a part of it by chemical combination with it. The alchemist's idea, however, was that his dye should be so intimate and complete that it should change the nature of the metal, and make it really become that to which it was made like. According to this school of operators, there were two fundamental dyes, answering to the colours of the two precious metals—Xanthosis, or dyeing yellow, and Leucosis, or dyeing white. It was further held that the two dyes, though differing in appearance, were one and the same substance. And it came to be thought that there was a master dye which, if it could be discovered, would be veritably a transmuting agent. The idea developed and gradually merged in that of the Philosopher's Stone. For instance Salmon, in the seventeenth century, describes the master substance thus: "The universal medicine for all imperfect metals, which fixes those that are volatile, purifies those that are impure, and gives a colour and brilliance greater than that of nature." The dye and the Stone coalesce.

It may be said that, although the idea of transmutation might merit the rank of "scientific," we here pass into the region of uncritical fantasy. Not so. The full excuse must wait until we come to discuss the philosophical basis of alchemy, and the doctrine of "qualities." But even on the ground of observations

from external happenings, we can see how the mistake arose. Experiences gained in the dyeing of cloth, enamels, glass, and the rest, deceived and misled. Moreover, the colour of metals could actually be changed by alloys, and by chemical actions. Under the circumstances, misinterpretations were natural and inevitable.

Dyeing the Metals.

Let us look into the matter a little more closely. These early alchemists knew that there are agents which can make a metal white—as mercury whitens copper; that there are agents which can make a metal yellow—as sulphur and arsenic can give a golden tint to silver. Nowadays we know that the changes result from the formation of new compounds. We must keep this knowledge out of sight, and join the alchemists in regarding the changes as dyeing processes of varying degrees of perfection. The less perfect the dye, the smaller the amount of transmutation effected. The two examples just given were not regarded as "fixed" dyes, for they could not resist the action of chemical agents or of fire—the transmutations were only partial. Whereas in the case of gold itself, the colour could resist such agents, and was one of the marks of the perfect metal. We may perhaps put ourselves most easily at their point of view if we suppose that the colour of gold, wherever it occurs, argues the presence of gold-nature. Then it follows that the more "fixed" the colour is, the nearer to being gold is the substance that possesses the colour.

It thus became an alchemist problem—legitimate on their premisses—to tint the base metals so deeply as to change their nature to that of gold or silver. According to the degree of success attained, so would the new product be gold or silver of greater or less fineness. That is to say, the genuine alchemist did not seek to deceive the eye, but to transmute. Brass, for instance, he would regard as a metal on the way to becoming gold; copper whitened by arsenic as a metal on the way to becoming silver; and so on. Let us remember that he had no idea of fixed elements; he thought in terms of transition processes—one thing passing over by stages into another thing. And the evidence of his senses seemed to be all in favour of his presuppositions. Genuine alchemy was not the mad, irresponsible art that so many have held it to be.

Other Qualities of Metals.

Obviously colour is not the only quality of a metal. Each has its particular weight, hardness, malleability, and so forth. Copper treated with oxide of zinc puts on a yellow tint and seems to be turning into gold. Yes, but the product can be distinguished from the metal it imitates. Coiners are keenly alive to this fact, nor were the alchemists forgetful of it. They extended the scope of their colour-theory. If a base metal could be made to acquire the colour of gold, why should it not be possible to devise means for similarly changing other qualities? Each change in the right direction—weight, hardness, or any other—would mark a fresh stage on the road to

perfection. But each change must be a real transmutation. Shall we recognise that this was a legitimate argument from analogy?

Come down the centuries to one who is regarded as the herald of modern science. We find him thus discussing the possibility of transmutation. "In gold, for example, the following properties meet. It is yellow in colour, heavy up to a certain weight; malleable or ductile to a certain degree of extension; it is not volatile, and loses none of its substance by the action of fire; it turns into a liquid with a certain degree of fluidity; it is separated and dissolved by particular means; and so on for the other natures which meet in gold. . . . He who knows the forms of yellow, weight, ductility, fixity, fluidity, solution, and so on, and the methods for superinducing them, and their gradations and modes, will make it his care to have them joined together in some body whence may follow the transformation of that body into gold." *

It does not need a critical knowledge of the Baconian terminology to understand the general drift of this passage. The governing idea is that men may come to have the means for so uniting the qualities found in gold as to produce the metal. This is true. Chemists may yet succeed in building up a metal. This speculation will be more fittingly discussed at the close, than at the beginning of our inquiry.

Fixed Elements.

But not by alchemist means. It is important to note the reservation. Let us return for a moment to

* *Novum Organon*, Second Book of Aphorisms, v.

the treatment of copper with arsenic. St. Thomas Aquinas mentions it: "Add to copper some white sublimated arsenic; you will see the copper turn white. If you then add some pure silver, you transform all the copper into veritable silver." It is plain that the great doctor misconceives the conditions of his problem. The modern chemist will explain that there is no change of copper into silver, but the formation of an alloy of the three ingredients—each being present in exactly the same quantity throughout, and each recoverable, by suitable means, in exactly the original quantity. That is to say, the alloyed silver is not an imperfect form of that metal, as the alchemists thought, but a compound of fixed elements. The alchemy of the future, should it come to flourish, will go to work with a wholly different set of fundamental conceptions. How far the atoms of the elements themselves are compounds will be considered later. The principle involved remains the same throughout—fixity of conditions, not growth.

Nevertheless the alchemists from the first had a suspicion that alloys were not true transmutations. Hence a distinction they drew between "natural" and "artificial" metals. The latter attained to a certain number of the qualities of the metal to be imitated; but did not attain to perfect likeness. And in proportion as accuracy in measuring, weighing, and testing was gained, so did the problem of alchemy become more complex. Superficial results did not so easily pass muster, and more delicate processes were tried. The parallel has been drawn, in this regard, with the increasing delicacy of present-day mixing of alloys and tempering of steel. We may

gladly accept it, because the cases are genuinely similar. And the application is closer than might at first sight appear; for the alchemists believed that gold and silver themselves were alloys, and could therefore be reproduced by proper compounding.

Imperfect Analysis.

Another source of error in alchemist conclusions was the imperfection of their methods of analysis. Consider Pliny's account of the gold-making instituted by the Emperor Caligula.* "He caused a considerable amount of orpiment to be calcined to get the gold out of it, and quite succeeded in making excellent gold." There was no attempt at fraud—all was in good faith. But the gold was there to start with, undetected. A modern chemist would have explained the situation in a few minutes; his tests are speedy and accurate. We cannot wonder that honest and careful observers were frequently misled into thinking that they had succeeded in producing or augmenting gold, when they were so poorly equipped for analysis of their materials.

Even Boyle was sorely perplexed by the result of a chemical action. He dissolved some gold in a "royal water" containing chloride of antimony. To his surprise there appeared "a noticeable amount of silver." He did not know that the chloride contained a certain quantity of this metal; and he was therefore tempted to believe that some sort of transmutation had taken place.

* Given in full, p. 18.

Two Receipts for making Gold.

It will be interesting, on several counts, to give in this context two receipts for making gold—one brief, the other more complicated. They are taken from an ancient treatise entitled *Mappæ Clavicula*—a manuscript of the twelfth century, with matter belonging to the tenth; the sources date back to Alexandrian times, and behind these again to the previous Egyptian period. The brief receipt is as follows: "To make gold—take silver, 1 lb.; copper, ½ lb.; gold, 1 lb., melt, etc." This would seem to be a case of plain falsification. The title of the receipt proves that the resulting alloy was to be passed off as gold. We must, however, distinguish between a merely empirical falsifier and a speculative alchemist. The former merely aims at scoring wealth. The latter looks on the alloy as an approach to what he wants—a stage on the path of transmutation. Many alchemists there were who would make bad use of the receipt; but with such we are not at present concerned. We are trying to understand what genuine alchemy stood for.

The longer receipt runs thus: "Take mercury, 8 parts; filings of gold, 4 parts; filings of good silver, 5 parts; filings of brass, and flower of copper called by the Greeks chalcantum (sulphate of copper), 12 parts; yellow orpiment (sulphuret of mercury), 6 parts; electrum (an alloy of gold and silver), 12 parts. Mix all the filings with the mercury to the consistence of wax. Add electrum and orpiment; then add vitriol and alum. Place the whole in a dish on

burning charcoal; boil it gently, sprinkling into it safran (probably an orange sulphide of arsenic) infused in some vinegar, and a little natron (carbonate of soda); 4 parts of the safran are to be used. Sprinkle little by little until it is dissolved and drunk up. When the mass is solid, take it and you have gold with increase. You will add to the preceding substances a little moonstone, which is called in Greek Afroselinum (selenite, a name applied to sulphate of lime, mica, and transparent felspar)." Here we have a mixture which might well defy the analysis of early chemists! The comparative simplicity of the result would be grievously disguised. Once again we must distinguish between the mere fraudulent operator who would consciously take advantage of the spurious metal, and the speculative alchemist who might reason himself into believing that the alloy was really and truly an imperfect sort of gold.

Precipitates.

Evidence of a like kind was furnished by the study of the precipitates of metals. For example, if a filing of copper be dipped into a solution of a silver salt, the copper is immediately covered with a coat of silver; or if an iron filing be dipped in a salt of copper, it is immediately covered with a coat of copper. Nowadays we are not misled by such phenomena. But we must remember that until comparatively recent times it was not known that the salts often include metals among their elements; nor was it suspected that metals could exist in solution in a liquid. For

us, blue vitriol (sulphate of copper) is a salt containing atoms of copper in combination with atoms of sulphur and oxygen; and when it is dissolved, the metal is in the solution. The alchemists, however, had no means of knowing this. The salt and the metal were, for them, simply different states of certain substances. And thus, when copper was deposited on an iron filing plunged in a solution of the salt, it appeared to them as a transmutation. We say that the atoms of copper in the salt are displaced by atoms of iron; they said that something was changed into copper.

An early example of the sort of reasoning employed is found in Æneas of Gaza * (fifth century). "The form subsists, while the matter undergoes changes because it is made to assume all these qualities. Let it be a statue of Achilles made of iron; suppose it is destroyed and its fragments reduced to tiny morsels. If now a workman collects this iron, purifies it, and by a peculiar science changes it into gold, and gives it the figure of Achilles, this will now be a golden statue instead of an iron one; but it will still be Achilles. It is in this way that the matter in bodies that are corruptible behaves, and by art becomes pure and imperishable." Æneas makes his meaning clearer by saying, a little further on, that "the change of matter into a higher condition has nothing incredible in it. It is thus that those learned in working up matter take gold and tin, make them apparently disappear, colour the matter, and change it into excellent gold." He evidently regards the intervening chemical actions, which "make the metals

* Quoted by Berthelot, *Les Origines de l'Alchimie*, p. 75.

apparently disappear," as so many stages in a transmuting process. Note the special mention of the operation of "colouring," and also the plain statement of the idea that matter can pass "into a higher condition."

This extract presents a very early attempt to explain chemical actions. We know more about them than did Æneas; we have reduced them to laws, and can calculate them by equations. But do we yet understand them? What really happens in such a familiar case as two atoms of hydrogen uniting with one of oxygen to form a molecule of water? Are the forms of the constituent atoms modified? Is the water-molecule really something other than a mere conjunction of two different substances? We are still groping.

Appeal to History.

We may class under the head of external evidence for transmutation the persuasive force of the testimony borne by generation after generation of adepts to the success of their efforts. So great was this that it must have required a mind of exceptional independence to resist it. As late as 1832, Schmieder, in his *Geschichte der Alchimie*, actually concludes that the weight of evidence in the seventeenth and eighteenth centuries is so remarkable that it impels belief in transmutation. We may well forgive, then, those who, in preceding epochs, honestly held alchemy to be a true art, even though they themselves had not succeeded. The great secret might illude them; but the appeal to history satisfied them that others, more learned or more fortunate, had penetrated it.

When we thus take account of natural inferences from imperfectly analysed chemical experiments and observations, reinforced by a no small amount of unquestioned testimony, we cannot wonder that belief in the possibility of transmutation was fostered and maintained. Even had there been no other causes at work, these would have sufficed to keep an edge on the never-diminishing desire to discover a short cut to the possession of unbounded wealth. But other causes *were* at work. And to the consideration of another, and not the least potent, of them, we will now turn our attention.

CHAPTER II

PHILOSOPHY OF TRANSMUTATION

WE have seen, in the historical sketch, that the alchemists derived the technical side of their art from the Egyptians. They were practical chemists and metallurgists. But they were also philosophers. They were students of Byzantine and Alexandrian systems which had fused certain doctrines of the Greeks with mystical and magical elements. And thus, though they were in quest of a discovery which involved manipulation of laboratory materials and apparatus, they brought to bear on their task the results of abstract thought. It was this combination of the theoretical and the practical that constituted the peculiar character of the Hermetic art. We have considered the external aspects of the belief in transmutation. We now turn to examine its philosophical bases.

A Passage from Psellus.

An excellent introduction to this phase of the subject is provided by an extract from a letter written in the eleventh century by a Byzantine alchemist named Psellus. The Patriarch Xiphelin had asked him to explain his art. Here is a passage in his reply.

"You desire that I should make known to you this art which resides in fires and furnaces, and which expresses the destruction of substances and transmutations of natures. Some believe that it is a knowledge for the initiate, held secret, which they have not attempted to reduce to a rational form—a thing which I regard as an enormity. For myself, I have sought from the first to know the causes, and to draw from them a rational explanation of the facts. I have sought it in the nature of the four elements from which all comes by combination, and into which all returns by dissolution. . . . I have seen in my youth the root of an oak turned into stone while conserving its fibres and all its structures, participating thus in the two natures" (that is to say, wood and stone). After quoting Strabo's account of the properties of an encrusting fountain which produced the forms of immersed objects, he proceeds thus: "In this way the changes of nature can take place naturally, not in virtue of an incantation, or a miracle, or a secret formula. There is an art of transmutations. I have wished to set forth its precepts and its operations. . . . You wish to know by what substances and by the aid of what science gold can be made. You would fain know its secret, not to have great treasures, but to penetrate into the secrets of nature as did the ancient philosophers. . . . I will reveal to you all the wisdom of Democritus of Abdera; I shall leave nothing in the sanctuary."

We note in this remarkable statement several points of great significance. Its scientific spirit shines out clearly—its reliance on knowledge of nature and on observation. There is the determination,

moreover, to get down to the causes of things—its philosophical temper. And there is the reference to Democritus, and through him to the whole field of Greek thought about nature. The core of the whole matter is the making of gold—transmutation.

Platonic Theories of Matter.

Psellus sends us to the Greeks, and to the Greeks we will go. Fortunately we can limit ourselves, for our special purpose, to the lines of speculation which centre in Plato and his followers. For the Alexandrian philosophy was largely Platonic in spirit and in substance.

Plato's theory of matter is obscure, and has given rise to much discussion. We are concerned, however, with its teaching as interpreted by the alchemists; and we can therefore steer clear of entangling controversies. The fullest exposition is found in the dialogue known as the Timæus.

We there find that he seems to teach the existence of an eternal "something" which can hardly be called matter. It is formless and indeterminate, beyond the reach of thought and the senses. Though so dimly apprehended and so hard to be explained, yet it underlies all things; it originates and constitutes the material universe—the principle out of which all things are formed. Plato calls it sometimes "the womb" or "mother" of all becoming. He conceived that the Creator imposed upon it certain forms, and that there thus came into being the four kinds of substance so widely declared to be "elements"—water, earth, air, and fire. Of these, he said, water is

related to earth, and fire to air. And the important point for us is that the series is not thought of as a succession of separate kinds of substance, but as showing a progress from the least to the highest degree of movement. That is to say, there is an upward curve in value and dignity. And there is thus a strong suggestion of the possibility of transmutation—of continuous change from one kind of substance to another.

Plato himself writes thus: "We see water condensing itself and becoming stone and earth; by splitting and dividing it becomes wind and air; an air inflamed becomes fire; fire condensed and extinguished takes again the form of air; air thickened changes into mist, and then runs as water; water forms earth and stone." It follows that if the elements can thus pass into one another, their properties are not fixed and determined. And an old commentator on Plato is therefore sound when he explains that "since things cannot ever conserve a proper nature, none can venture to affirm that any one of them is such and such a thing, rather than something else."

Hence a problem. If substances can thus pass from form to form, how far, and by what methods, can man intervene to retard or hasten the transitions? Bacon states this problem in the first Aphorism of the second book. "On a given body to generate and superinduce a new nature or new natures, is the work and aim of Human Power." And in the same Aphorism he gives as a secondary work to be undertaken "the transformation of concrete bodies, so far as this is possible."

Platonism and Alchemy.

The alchemists assimilated this teaching—so completely that Geber, the great master of the Arabian school, goes to the length of asserting that metals cannot be transmuted until they have been reduced to their "first matter." In other words, he not only maintained that metals are compounded out of this "mother stuff," but also that, if they are to be brought by artificial means to higher states of perfection, they must necessarily first be decomposed into their primordial condition. This teaching affords a striking example of the influence of philosophy on laboratory operations, and with various modifications, retained its hold down to the days when alchemy was decadent and discredited.

A typical instance is found in the writings of Basil Valentine, an adept of the thirteenth century. The following passage is clear and to the point: "Think most diligently about this, bear it often in mind, observe and comprehend, that all minerals and metals are produced and generated in the same time and in the same fashion, and of one and the same principal matter." This is simple and straightforward. We must not, however, imagine that all who developed the central idea were equally sober-minded, or that their teachings were always in harmony with each other. Many were vague and incoherent, mystical and fantastic. But we should not on that account deny the rational element which underlay them all, and which from time to time reasserted itself in the speculations of the nobler sort of adepts.

Take as a favourable example of an attempt at a rational development of the Platonic doctrine the system expounded in the works of the Valentinus above quoted. He sets out from the idea that beneath all the sensible qualities of a substance there is an incorporeal Essence. He therefore distinguishes the specific bodily, or material, part from the Spirit.* In the bodily part he holds there are the four generally recognised elements—earth, water, air, fire. So far there is nothing really new. But he then makes an advance. He holds that from the relations between pairs of these elements result what he calls the three Principles. Fire acting on air produces Sulphur; air acting on water produces Mercury; water acting on earth produces Salt. The Sulphur, Mercury, and Salt thus produced are not to be thought as being of the ordinary sort in common use. They have an exalted or sublimated nature which implies special powers and virtues, and become a recognised Triad for alchemy, as distinct from the Four of philosophy.

Can man make the three Principles out of the Elements? No, says Valentine; God alone can do that; man has simply to accept them. But man can go to work with the three Principles and mingle them in various ways and proportions. He is thus able to effect transmutations of the substances with which he is actually dealing.

The strangeness of this speculation may blind us to its merits. It is an original attempt at analysis. And we may parallel its conclusions under our modern conditions. May we not fairly say that the place of Valentine's Principles are our chemical "elements"

* For a further consideration of this, see the next chapter, p. 107.

which the scientist can neither make nor unmake? But he can combine them in endless ways and proportions. Eliminate the idea of a passing of one substance into another, substituting that of a building up of fixed kinds of atoms, and the kinship of the old and the new is apparent.

As regards the underlying Essence, Valentine says it is hidden by the wrappings of Elements and Principles. But though impalpable, it acts as a mystic uniting bond. Have we not here an anticipation of the modern concept of the ether of space? Read any recent account of this mysterious, illusive, all-pervading entity postulated by our physical philosophers, and you will sympathise with Valentine's speculation.

The Mercury of the Philosophers.

What has preceded will enable us to apprehend the alchemist notion of what was called "the Mercury of the Philosophers." It was reached in this way. By a specialised application of the doctrine of a "first matter," adepts came to think that there must be some particular kind of substance which is the basis of all the metals, rendering them all essentially of a uniform composition. The differences between them are due to various colouring matters and impurities. For various reasons to be given later, the metal mercury had attracted exceptional attention, and it was generally agreed that this was the common inmost substance of the metals. Theory and practice, however, were here at loggerheads. For it was

painfully evident that the ordinary mercury could not fulfil the exciting demands made upon it. The adepts saved the situation thus. They maintained that the ordinary metal is not the real thing, but that its essential virtues are negatived and disguised by various qualities and impurities which impair its perfection. Thus its liquidity argues the presence of the fluid element, water; its volatility, that of the light element, air; its grossness, that of the heavy element, earth. These must be stripped away, and then the refined substance remaining would be the true "first metal"—not volatile or liquid, but "fixed," that is to say, ideally stable and solid. To this "first metal" they gave the honourable name of "the Philosopher's Mercury." By means of it, the happy possessor would be able to produce artificially any metal he liked, gold among the rest. Hence it was that the alchemist's aim is so often defined by reference to this wonder-working substance. He laboured to "fix mercury." *

The Composition of the Metals.

Although the Philosopher's Mercury was regarded as the "first metal," the base common to them all, it was not generally held that it was the only constituent. The Arabians said that sulphur must be united with it, and that it was owing to the varying proportions in which the two were combined that the metals differed from one another. The doctrine was developed by their successors. A typical mediæval

* For a grim jest on this, see p. 42.

form of it goes into detail thus. Gold is engendered by a clear mercury associated with a clear red sulphur; silver by a clear mercury and a white, or slightly red, sulphur; iron by an impure mercury and a sulphur white and clear; lead by a thick mercury and a white sulphur, thick and a little red; and so on. The question does not seem to have been dealt with as to what the impurities are. Perhaps it is covered by the idea of a passing through stages to perfection.

A further cause of the differences was found in the amount of baking which the mixtures had undergone down below in the earth. (The notion that they "grow" comes under another head.) Gold, for example, was baked a long time at a gentle heat; silver, some said, required a hundred years to bake; iron was metal spoilt by too much baking; tin, if further baked, would become silver; lead is detestable sulphur badly baked. The idea of passing through various stages is still fundamental.

Sulphur.

If we ask why sulphur should be chosen as a necessary ingredient in the composition of metals, the answer still keeps us in touch with Greek philosophy. The element of mercury provided the metallic properties, such as lustre, malleability, ductility. But the fact that fire had the power of altering metals had to be accounted for. Now Plato had taught that fire is a substance—excessively attenuated, indeed, but nevertheless to be ranged with air, water, and earth. There are several kinds of it, he says; flame

which gives light to the eyes without burning them ; and fire which remains in substances that have been enflamed, after the flame is extinct. The alchemists came to associate their elemental fire with the sulphur of the Philosophers. To this constituent was attributed the "combustibility" of metals, by which term was intended their alterability under the action of fire.

The notion of fire as a real substance compounded with, or shut up in, other substances, was very persistent. It made its last appearance in the famous *Phlogiston* theory, promulgated by Stahl at the beginning of the eighteenth century. Briefly stated the theory was this. When a substance burns, it is losing phlogiston ; the flame, heat, and light are evidence of the violence of the process. All combustible substances contain phlogiston as a common principle. It is so intimately combined with them that it cannot be seen until it is escaping. That which remains after combustion is the original substance minus its phlogiston.

Apply this to the metals. Some of them, such as zinc, can be made to burn, and earthly substances remain. Others, like lead and mercury, do not burn ; but if exposed to heat lose their metallic appearance. It was therefore argued that the metals were compounds of phlogiston and the materials that were left after the combustion. Moreover, the colour of the metal was connected with the amount of the phlogiston contained. For example, if lead is heated, it yields litharge—a yellow substance ; if heated further, it yields red lead. Evidently, said the champions of this theory, there are different quantities of the

fire-substance present. Could the phlogiston be put back again? Yes, in not a few cases. Thus, if the dephlogisticated zinc—the earthy substance remaining after burning—be heated with wood or charcoal, the metal reappears! It has acquired a fresh stock from the burning of the wood or charcoal.

Here we have the alchemist doctrine in a scientific dress. Substitute sulphur for phlogiston, and the essential features in the two are the same. The later experimenters did not lay such stress upon the "first metal" substance, and they worked out their theory much more thoroughly and logically; but the root principle is the same.

Now Stahl's theory led up to the discovery of oxygen. It focussed attention on the phenomena of combustion, and brought together the scattered facts by means of an explanation which, though erroneous, enormously helped scientists to get on to the right track. Why should we be so unfair as to deny to the alchemists the merit of preparing the way for Stahl? Follies and falsities ought not to obscure the share they had in achieving the ultimate success.

Theory and Practice.

We have now seen how Greek philosophy largely moulded the development of the Hermetic art. Let us get a general idea of the way in which the alchemists set about their task.

Some particular substance, usually a metal, would be chosen as likely to allow of transmutation into silver or gold. The great object then was to strip it

of those qualities, or properties, in which it differed from the metal required. Lead, for instance, must be stripped of its easy fusibility, tin of its peculiar "cry," and so forth. The proper tint must be produced; the right degree of hardness, malleability and ductility; the right weight; the characteristic lustre. Transmutations were in any case always in process. Art must aid them and speed them up. A short cut, so to speak, would be possible if the Mercury of the Philosophers, or, what was practically the same thing, the Philosopher's Stone, could be discovered, for then this Magisterium, or Master Substance, would by its own powers and virtues effect the changes.

Since it was commonly held that a substance could not be transmuted unless it were reduced to the "first matter," and since this first matter would, in the case of the metals, be the Mercury of the Philosophers, the two methods tended to coalesce. If transmutation were accomplished, the Mercury must have been won. If the Mercury were won, the power of transmuting would be gained. Hence much confusion in aim and statement. At one time the precious metal would be the direct object in view, at another the Philosopher's Stone. But in both cases the underlying conceptions of the nature of matter were the same—those derived from Greek philosophy. The triad, Mercury, Sulphur, Salt, were simply the old quartet, earth, water, air, fire. The concentration on chemical operations explains naturally the preference for the specific substances.

Qualities as Separate Entities.

There arises out of the statements just made a further point which it is important to understand if we would enter into the minds of the alchemists. Several times the expression was used, "a substance must be stripped of certain of its qualities." Vincent de Beauvais definitely claims that adepts "can rob substances of their qualities." Now we must be prepared to interpret this language literally. That is to say, we must realise that the alchemist imagined the qualities of substances to be separate things existing in their own right. We need not go deeply into the metaphysics implied. It will be enough to grasp the profound difference between their point of view and ours. When the operator who would "fix" mercury determined to get rid of its volatility and liquidity, he had much the same idea in his mind as a man who would fish out of a liquid any substances that were scattered through it.

Let us contrast our way of viewing a parallel process. If a man condenses some steam into water, and then freezes the water into ice, he does not imagine he is robbing the original substance of any of its qualities, but merely that he is causing it to change what we call its "states." He is causing the molecules of water to come closer and closer together. The alchemist, on the other hand, would conceive that when he had condensed the steam, he had robbed it of a quality that made it an "air"; that when he froze the water, he had robbed it of a quality that made it a liquid. Two really existent things had been

abstracted from it. It was thus that by stripping off the disguising qualities from ordinary mercury, he hoped to get a residue that would be the Philosopher's Mercury. It is clear that this profound difference must be kept well in view if we would interpret aright the theories and receipts in alchemical treatises. The subject will come before us in another context. Meanwhile let us acknowledge that the Hermetic art, taken at its best, was founded on observation and reason.

CHAPTER III

ALCHEMY AND ANIMISM

ANOTHER range of ideas, akin to, but less strictly philosophical than, those considered in the last chapter, strengthened and enriched the belief in the possibility of transmutation. The alchemists were from the first deeply impressed by the processes of growth in the world of plants and animals. And they conceived that inorganic substances, more particularly the metals, were endowed with a kind of life similar to that of organisms. In fact, broadly speaking, they adopted the fundamental principles of what is known as Animism.

It is sufficiently well known that primitive man interpreted the events and changes around him on the analogy of human activities; he looked upon them as manifestations of living wills. The noisy brook, the roaring waves, the cracklings in the woods, no less than the growing tree or the beast of prey, for him argued the presence of life. Indeed it was only by such a view that he could at all understand them or bring himself into practical relations with the things around him; for he knew of no mode of activity other than his own. This original tendency persisted on into times when reflective thought, such as that of the earliest Greek philosophers, strove

to enter more deeply into the nature and causes of the phenomena of the external world. Mythology yielded place to idealisms, gnosticisms, pantheisms; the belief in distinct beings behind natural phenomena weakened or disappeared; but the belief in some form of universal life lasted on. And alchemy, in its turn, was largely influenced and moulded, from first to last, by animistic conceptions and speculations.

METALS GROW.

We have seen that the view the alchemists took of the nature of metals was very different from ours. They imagined that by a series of slow changes under the earth they were progressing towards perfection. They were the more imperfect the more easily they were changed by fire and chemical agents. For instance, lead and iron were imperfect because they yielded so easily to such agents. Gold, on the contrary, strongly resisted them—indeed, most strongly of all. It was therefore held to be the perfect metal which all others were striving to become.

The alchemists, however, went much further than this. For them, the changes were not, as we might suppose, of a purely physical kind, but were imagined to take place by a living process. They held that metals *grow*, like plants. We moderns can follow them to some extent in the notion of change, and can understand how the ancients came to think that the change was progressive. For we know that metals are found in ores of all degrees of purity or impurity, and that some of them at times are discovered in

their "native" state. It is not difficult to see how, in the ignorance of the true nature of what we call "the elements," this varying degree of purity might give rise to the belief in an upward progression. But the notion of "growth" is so far removed from our present modes of thought that we are tempted to regard it as a flight of unbridled imagination. And yet, in the popular mind at any rate, it persists even in this enlightened age. A poet is warranted in describing stones as hewn from "the living rock." And there can be little doubt that many still harbour a vague theory that under the earth minerals and rocks do somehow come into being and increase. (In the days when coal was being formed, there would be a certain amount of justification for it!) But that metals actually *grow*—that is a different matter.

The alchemists, however, put a yet greater strain on our capacity for sympathy. Having entertained the notion of growth, they developed it with a startling thoroughness. Metals, they held, grow like plants. How do plants start their life? From seed. Since nature proceeds on the same plan throughout, there must be something corresponding to seed in the case of metals. They could not define exactly what this metal-seed was, but they felt quite safe in assuming its existence, and determined to discover it in order that they might "grow" metals as they grew plants. The processes, of course, would be different, but the principle would be the same. The seed, once obtained and put under proper conditions, would set out on a course of development which would ultimately give them the perfect metal. Under the earth the growth

was indefinitely slow, and was hindered in many ways; they would by artificial devices come to the aid of nature and speed up her operations.

Such was the train of reasoning which led to these strange conclusions, kindled such chimerical hopes, and prompted such endless labours. And yet even here we must not be too hasty in condemnation. Does not modern chemistry aim at speeding up divers "natural" processes? Does it not build up molecules, and increasingly aim at invading the sphere of life itself by fabricating organic compounds? And do we not speak of the "growth" of crystals—a term which some think to be more than a figure or analogy?

Given the premisses, the alchemist's reasoning was logical. He had to meet, however, an obvious difficulty. If the seed of metals develop into the perfect metal, gold, whence come the baser metals? The explanation advanced was singular. The formation of these was regarded as due to a thwarting of nature's purpose. Resistances were encountered which could not be overcome. Iron, tin, lead, and the rest were compared to abortions or monstrosities. Again modern science can help us to seize their idea when it describes to us the clash of forces which cause malformations in crystallisation, or which altogether preclude it. There are few of the really fundamental concepts of alchemists that are quite beyond the pale of such suggestive parallels; and although they were so largely the outcome of imaginative guessing advances in science may prove them to possess unsuspected kernels of truth.

Metals and Animal Birth.

Certain of the alchemists were not content with referring to the plant world when they speculated on the development of the metals, but brought in notions derived from the generation and birth of animals. Applying still more thoroughly their doctrine of the unity of plan and action in nature, they likened the genesis of metals to that of the fœtus. The comparison is at least as old as the time of Geber. This Arabian father of the art, in one of the works with most confidence ascribed to him, works it out in detail, and includes the concepts of marriage, conception, rearing, and education, claiming that the conditions these imply are as necessary in the case of metals as of human beings. The lead he gave was sedulously followed up, until it lost itself in the mystical absurdities of the latest phases of the art. Some did not shrink from distinguishing between male and female elements in the process, affirming that there must be a conjoining of sex-elements before metal-growth can be initiated.

At this stage, the protests of the enlightened critic become vehement; and it requires no small amount of courage to resist them. Nevertheless it may be urged that, stripped of foolish accretions, the notion is a logical result of the original animism. Moreover, we may ask ourselves whether we have yet fathomed the nature and function of sex distinctions in the great upward curve of evolution. If there be no dividing line between the organic and inorganic (as so many now assume), how far down does the sex

principle descend? He is a bold man who ventures to dogmatise.

Dying and Reviving of Metals.

The comparison of the generation of metals to that of plants involved another notion less defensible. The ancients, as we saw, thought that a seed actually died before it could germinate to new life. The discoveries of modern botany have shown us how imperfect, and, indeed, false, was such a view; it tells us of cotyledons, stored albumen, and so forth. We must go behind all this if we would be fair to the alchemists, and look at the process with their eyes as involving complete death and resurrection. The conclusion was almost forced upon them that, if metals grow from seed, there must be in their case also a dying and reviving. Some of them even speak of the "killing" of a metal as a means to transmutation.

This notion was greatly strengthened by the prevailing belief in the possibility of spontaneous generation—the belief which roused such fierce controversy in quite recent times, and which, in a far subtler form, is again asserting itself. The connection is well seen in the following passage from Basil Valentine: "Neither human nor animal bodies can be multiplied or propagated without decomposition; the grain and all vegetable seed, when cast into the ground, must decay before it can spring up again. Moreover, putrefaction imparts life to many worms and other animalculæ. . . . If bread be placed in honey and suffered to decay, ants are generated. . . . Maggots are also generated by the decay of nuts,

apples, and pears. The same thing may be observed in regard to vegetable life. Nettles and other weeds spring up where no such seed has ever been sown. This occurs only by putrefaction."

It is needless to say that Valentine's instances are capable of quite other explanation; but he erred in good company, and he makes plain the principle he wishes to establish. He proceeds to give it the alchemical application. "Know that in like manner no metallic seed can develop or multiply unless the said seed by itself alone, and without the introduction of any foreign substance, can be reduced to a state of putrefaction." His practical inference is that gold must be brought to putrefy and die if there is to be a new life for it with increase of its substance.

Consider how puzzling must have been such an experiment as this. They would take a metal, say lead, and calcine it in the air. They watched it lose its well-known appearance and change into a powdery kind of cinder. Assuming, as they did, that the metal had a life of its own, what more natural than to say that it had died? It was in the condition which they imagined a seed would be that had died in the ground. They then reheated this cinder in a crucible along with some grains of wheat. They watched the metal taking on again its wonted characteristics and resuming its original state. What more natural than to suppose that the life in the grain had brought about a "resurrection" of the metal? We, of course, know that it was the carbon in the wheat which took from the lead the oxygen it had combined with in the first calcining. But they had nothing to guide them to

such an explanation, and should not, therefore, be charged with folly for arguing as they did. The blame comes in when some of them, starting from this misunderstood chemical action, gave loose rein to their imagination, and launched out into all manner of occult and mystical theories which led them further and further away from the world of facts. These aberrations, however, should not tempt us to ignore the rational character of the broad considerations of which they were the perversions.

Metals have Body and Soul.

It has been shown how that the alchemists, setting out from the comparatively simple idea of a metal-seed analogous to the seed of plants, introduced the more complicated ideas connected with generation in the animal world. They were not content to stop at even this advanced stage of speculation. Man is the crown of the animal world, and consists of body and soul. They asked themselves whether a similar distinction does not exist in the case of metals, and decided in the affirmative. And having ventured on this further analogy, they developed it with the utmost seriousness and exploited it in their practical work.

The philosophical basis for their notion was largely derived from the teachings of the Platonists. According to these mystical idealists man's body was an incumbrance—a clog on the activities of his true nature. It had therefore to be subdued and mortified before that true nature could show itself. If, then, the richest virtues of the metals were to be free for higher

transmutations, their material form must be destroyed. Thus in the seventh century an alchemist, Stephanus of Alexandria, declared that "it is necessary to deprive matter of its qualities in order to draw out its soul." And thus, too, in the sixteenth century Paracelsus declared that "nothing of true value is located in the body of a substance, but in the virtue. . . . The less there is of the body, the more in proportion is the virtue." Between these two writers there is a gap of nearly a thousand years! Yet the continuity of the doctrine is manifest.

But by some of the Hermetic philosophers a further refinement was elaborated. They made a threefold distinction—body, soul, and spirit. Spirit was conceived to be a primal element, not peculiar to any one substance but fundamental to all. We may perhaps say that it was "first matter" sublimated into a "universal essence"—the spirit of nature. The soul, on the other hand, was held to be the particular life that characterised any substance or group of substances; that is to say, it was specific, not universal. A substance was held to be more perfect the more it contained of this essence. Gold, being the most perfect of all, was richest of all in this regard. But even gold did not exhibit the essence in complete purity; it obscured it by possessing certain specific properties which had to be stripped off before the "spirit" could be really free. And the stripping of it was the supreme problem which the practical alchemist had in view. It was these imperfections that led the alchemists to distinguish between ordinary gold and "the gold of the sages"—the latter being the pure essence.

This doctrine, of course, applied to all substances; for all contained some portion of the essence. Mercury and sulphur were specially singled out because of their supposed alchemic virtues, though gold stood out pre-eminent. And in every case the problem was how to strip away the specific qualities. The first step was to free the soul from the body. Let Stephanus of Alexandria again instruct us. "Copper is like a man; it has a soul and a body. . . . The body is the ponderable, material, terrestrial thing, endowed with a shadow. . . . After a series of suitable treatments, copper becomes without shadow and better than gold." That is to say, the material form of the metal must be destroyed. Success in this attempt will lay bare that subtler part of it which lends itself to transmutation.

But from the standpoint of the threefold division of the nature of a substance, this first operation does not suffice. It would only render active the power of transmuting into a substance like that under treatment—the soul of copper would transmute other substances into copper, that of lead into lead, and so on; whereas the aim was to transmute into gold. A further stripping is therefore necessary. The soul must be removed, and nothing but the spirit, or universal essence, remain. *Hoe opus, hic labor est!* The quest was declared to be not merely long and laborious, but even perilous, demanding the highest qualities of intellect and character. Nay, prayer was often judged to be a necessary condition of success.

This notion of a "spirit" contained in substances did not wholly rest, however, on analogies borrowed from doctrines concerning the nature of animals and

man. The alchemists were impressed by certain empirical phenomena which transcended their powers of explanation. The power of a magnet, for example, is mysterious even to us; much more was it mysterious to them. More especially striking was its power of attracting iron in spite of the presence of intervening substances. This "virtue" seemed to them to argue the action of some "spiritual" force, intangible, invisible, pertaining to the inmost nature of the attracting body, and also of that attracted. They placed in the same category of subtle essences the action of poisons on organisms, supposing that the permeating power was due to some force which could be regarded as "spiritual" in its nature.

Introduction of Moral Ideas.

It was not, therefore, any considerable step onwards to endow substances with moral qualities. For if they possess that which constitutes the highest part of human nature, they would also possess its characteristic activities—the moral among the rest. Modern thought entirely rejects such a notion. It strives to be perfectly objective, assuming that the physical universe is wholly under the sway of unvarying, determinate, natural laws. Accordingly science raises no moral questions in studying physical phenomena, not even as regards the uses to which substances are put, much less any supposed inherent good or bad qualities they may manifest. The juice of a plant, for instance, is studied purely for its own sake, its composition, its effects, quite irrespective of the use any individual may put it to—say, to heal or to

poison. Or in the case of such a drug as alcohol, it finds a place for it in a certain interesting series of chemical compounds, and describes its various properties; notes its powers as a solvent, its effects on living tissues, and so forth. But it leaves to the moralist and social reformer practical questions regarding its consumption by human beings; and would scorn the idea that the drug is intrinsically evil.

The alchemists had not attained to this objective way of studying their materials. They read themselves into what they observed in their experiments, and thus unduly confused both their theory and their practice. It is curious to observe how traces of the old modes of thought survive in some of our most scientific terminology. We still speak of "base" and "noble" metals, of "good" and "bad" conductors of electricity, of "perfect" and "imperfect" gases—terms of distinctly moral connotation, though, in such connections, their real force is now severely ignored or completely forgotten. They may still serve, when historically considered, as aids in putting ourselves at the alchemist's point of view.

We saw that in supposing a "spirit" in substances, there were certain material phenomena which strengthened the leadings of philosophical speculation. So it was here also. Consider the effect on the alchemist mind of such an experiment as this. Some mercury is allowed to fall in a fine rain on to melted sulphur. A black substance is produced. When this black substance is heated in a closed vessel, it is volatilised and condenses into a beautiful red solid. We now know that the black product is the same as the red,

being composed of the same quantities of mercury and sulphur. But the alchemists did not know this, and attributed the change to the influence of fire as a purifying agency which could modify the actual qualities of substances. And here comes in the transition to moral ideas. Black was for the alchemists the symbol of darkness; red the symbol of light. By an almost inevitable association of ideas the experiment is interpreted as a change from bad to good.* Thus once again we find that, if we are to be fair, we must not hastily attribute to the play of irresponsible imagination notions which, being so far removed from our own, appear strange and fantastic.

Reviewing the whole development of these animistic speculations, we may arrive at this general conclusion. The exaggerations and follies which accumulated round them are rightly to be condemned. Nevertheless they contain a solid core of reasonable inferences which, in not a few cases, have their sequels or analogies in scientific speculations of the present day.

* This and several other examples and quotations in this chapter are taken from Muir's *Story of Alchemy*.

CHAPTER IV

MAGIC AND ASTROLOGY

THE popular idea of an alchemist in all the stages of the development of the Hermetic art, and down to our own times, is that of a man who lays claim to magical powers, who is skilled in the occult sciences, and who invokes the aid of unseen beings, chiefly of the undesirable sort. There can be little doubt that the grounds for this idea are by no means inconsiderable. Nevertheless, as Figuier argues, the *rôle* played by magic is very greatly exaggerated, and a wholesale condemnation on this score is grievously unjust. Let us try to arrive at an estimate founded, not on popular opinion, but on the historical facts.

Early Metallurgy and Magic.

We must acknowledge that alchemy had a bad start. For from remote antiquity those who busied themselves with the extraction and working of metals were regarded as enchanters and magicians —as having something supernatural about them. The Greeks thought of their master-smith as a god —Hephæstus, the Roman Vulcan. Legend pictured him as toiling in a marvellous workshop, in which various wonders were fashioned. The Cretans had

their Telchines, reputed the first workers in metals, and of ill-fame as spiteful enchanters. So it was with the Duergars of Teutonic myth, malicious beings who wrought in northern mines. So, too, with the supernatural Daktuloi of Mount Ida in Phrygia, to whom the discovery of iron was attributed, and the art of treating it by fire. In Teutonic Saga, we have our Wayland the Smith, a kind of demi-god, the hero of many exciting adventures. Nor can we be surprised that magic should thus widely be associated with metallurgy. The discovery of metals, and the art of working them, meant much in those early days—power in war, advance in civilisation. And the processes employed were so little understood that they seemed to surpass the limits of human knowledge and skill.

Yes, alchemy had a bad start. And the position was made the worse by the fact that alchemy was engaged, not with ordinary metallurgy, but with the transmuting of base metals into gold, and that it opened up prospects of boundless wealth. Add the decoction of an elixir which would indefinitely prolong the term of human life, and we see ample reasons, not only for the popular view, but for the belief not seldom held by adepts themselves that supernatural powers must be enlisted if success were to be attained.

Attitude of the Church.

The reputation for magical arts frequently roused the suspicion and hostility of Christian theologians. Some, indeed, were inclined to regard the very attempt at transmutation as an encroachment on the

divine prerogatives. Zosimus and Tertullian, for instance, attributed the origin of alchemy to the teaching of bad angels. The notion is as old as Genesis, with its tree of knowledge, its demóniac temptation, and its condemnation of the founding of cities, and of their attendant arts and crafts. The passage from this book which asserts that the sons of God took wives from among the children of men is often quoted by Tertullian and others who shared his views. The story had been adopted and expanded in the book that bears the name of Enoch—the patriarch whose life was passed in those fateful times. There we find that these sinful angels "dwelt with mortals and taught them sorceries, enchantments, the properties of roots and trees, magical signs, and the art of observing stars." They betrayed the secret of worldly pleasures, showed how to obtain gold and silver and things made of them, and taught the art of dyeing fleeces. We note the combination of the making of gold, the observing of stars, and the practice of magical incantations. The application of this to alchemy was obvious.

In the Middle Ages the suspicion was intensified rather than removed. For in those times of dark superstitions, every fact that transcended ordinary experience was attributed to supernatural agents, good or bad. And any man who exhibited unusual powers or made unfamiliar experiments was branded with the dangerous name of sorcerer. The tendency to such unfavourable judgments was increased by the attitude and behaviour of many of the adepts themselves. Some who knew that they were guiltless of the charge against them could not resist the temptation

of leaving uncontradicted, if they did not actually foster, the rumours which shrouded them with an air of mystery and enhanced their reputations. Others consciously traded on the popular ignorance. How dearly they sometimes paid for the advantage we saw in the historical sketch; also how the Church drew a distinction between white and black magic, and how, by virtue of this distinction, even Popes freely and ardently practised alchemy. Speaking generally, we may take it that in this mediæval period magic and sorcery were much talked of, but were in reality little practised. Here and there an adept might dabble in the dark lore. The great majority, however, confined themselves to arduous labours in their laboratories.

Alchemist Magic and Philosophy.

Though the varied forms of magic are mainly products of imagination, alchemists sought to vindicate their acceptance of them by referring to the teachings of philosophers. Plato, Pythagoras, Democritus, and other great authorities, were held to have been magicians. True, they had not left any evidence of this *rôle* in their authentic writings; but tradition generously supplied the deficiency, and enthusiastic adepts composed treatises which they published under the shelter of their venerated names.

The most celebrated of these philosopher-magicians was Iamblicus, the Alexandrine, who lived in the fourth century. He was accounted a Neo-Platonist, although his teaching was in many important points of quite a different trend More especially he held

that man could communicate directly with the Deity not only through his spiritual intuitions, but also through the medium of magic rites. He studied the "mysteries" of the Egyptians, Chaldeans, and Assyrians, concerning which he wrote one of his longest treatises. His great reputation did much to strengthen the bond between alchemy and superstition, and his influence lasted down to the period of decadence.

Another connection between alchemical magic and philosophy is found where we might little expect it. A sort of alliance was struck up between adepts and Stoic thinkers. It came about in this way. One of the Stoic doctrines emphasised the reign of a law of constant change in nature. "Watch (says Marcus Aurelius) how all things change continually, and accustom yourself to realise that Nature's prime delight is in changing things that are and making new things in their likeness. All that is, is as it were the seed of that which shall issue from it." Such teaching was eminently congenial to Hermetic philosophers, whose belief in the possibility of transmutation was based, as we have seen, on this very conception of substance passing from form to form; and they gladly took advantage of the reasoned proofs by which it was supported. Another doctrine of the Stoics was, that behind all the changes is the divine Substance, of which all things in the universe partake in varying degrees. The sun, moon, stars, and planets, being specially near to God, may be looked upon as divinities. The Stoics, in their endeavour to prove this doctrine, were in their turn glad to lean upon sages whose practices dealt with the

supernatural; and they therefore became ardent defenders of magic, astrology, and alchemy. The interdependence thus established was far-reaching and lasting in its results.

Astrology and Alchemy.

Most alchemists believed that the planets had the power of maturing metals, and so could influence the operations which aimed at their transmutation. Concerning the pseudo-science, or art, of astrology, there is no need to enter into detail. For the astrologer, as such, confined himself generally to judging the influence of the heavenly bodies upon human affairs, and to foretelling events by their position and aspects; whereas the alchemist was concerned with substances and their changes. The ground common to both was that the planets were active agents.

It was natural that the Arabians, under the sway of Eastern star-lore as well as of Alexandrian philosophy, should believe in astral influences. Geber, for example, held that the planets, arrived at a certain point of the sky, aided the forming and perfecting of the metals, whether under the earth, or when manipulated in the laboratory. He denied, however, that man had power to direct or use this influence, and so saved himself from the cruder superstitions of his time. Kalid went so far as to say that the action of the planets constituted one of the greatest difficulties in regulating chemical operations. The ruling ideas on the subject were mainly derived from that strange store-house of heterogeneous materials, the

Hebrew Kabala, and were adopted and developed in the strangest ways by mediæval and Rosicrucian adepts. Some of the ideas are more ancient, and can be traced back to the Babylonians. Geber asserts that "the conjunction and the revolution of the seven planets across the spheres of the signs (of the zodiac) direct the mutations of the four elements, make them vary, and allow of their being predicted." The Sabæan origin of the idea is plain, though it is presented as coming from Pythagoras and Aristotle.

A passage from Basil Valentine (fifteenth century) will show how such notions took root and developed. "Matter is no other than a mere vapour, which is extracted from the elementary earth by the superior stars, or by a siderial distillation of the macrocosm; which siderial hot infusion, with an airy sulphurous property, descending upon inferiors, so acts and operates that there is implanted spiritually and invisibly a certain power and virtue in those metals and minerals." The statement is vague, the terminology intentionally technical and obscure. Still the main purport is plain—a ponderous attempt to give fuller detail to the Arabian doctrine.

The Metals and the Planets.

A prominent feature of alchemist astrology is the assigning of the chief metals to the sun and the planets. The individual assignments are not always the same; but Chaucer's quaint list in his Chanoun's Yemannes Tale gives those most usually accepted:

> "The bodies seven eke, lo! hem heer anoon;
> Sol gold is, and Luna silver we thripe,
> Mars yren, Mercury quik-silver we clipe,
> Saturnus leed, and Jupiter is tin,
> And Venus copper, by my fader kin."

This mystical connection is probably due to the Babylonians; but knowledge of it was widely disseminated. Pindar, for example, mentions the relation between gold and the sun.* The scholium on the passage is also full of interest. "To each of the planets some substance is attached. To the Sun gold, to the Moon silver, to Ceres iron, to Kronos lead, to Zeus electrum,† to Hermes tin, to Aphrodite bronze." A condensed account, from a treatise entitled *The Open Entrance*, will furnish an example of how in later alchemy these astrological ideas were combined with chemistry. The author is describing the various stages in the perfecting of the Philosopher's Stone. I quote from Muir.‡ "The beginning of the heating of gold with mercury is likened to the King stripping off his golden garments and descending into the fountain; this is the regimen of (the planet) Mercury. As the heating is continued, all becomes black; this is the regimen of Saturn. Then is noticed a plan of many colours; this is the regimen of Jupiter; if the heat is not regulated properly, 'the young ones of the crow will go back to the nest.' About the end of the fourth month you will see 'the sign of the waxing moon,' and all becomes white; this is the regimen of the Moon. The white colour

* Isthmian Odes, IV, 1–3.

† Electrum was originally an alloy of gold and silver. See p. 182.

‡ *The Story of Alchemy*, p. 72.

gives place to purple and green; you are now in the regimen of Venus. After that, appear all the colours of the rainbow, or of a peacock's tail; this is the regimen of Mars. Finally the colour becomes orange and golden; this is the regimen of the Sun."

Signs and Symbols.

It was only natural that the mystical signs for the planets should be used for the metals—seven planets, seven metals, seven colours, and seven transformations. Mathematical figures, also, were pressed into the service of the art, and used with specialised mystical significance. The sign for fire was a circle with a centre point; that for air a triangle; that for water a square; that for earth two equilateral triangles interlaced to form a regular polygonal star. It is evident how the use of such signs, carrying with them the rich and varied associations of ancient and mediæval star-lore, lent themselves to the invention of endless fantasies and superstitions. We must not forget, however, that few of the better sort among adepts paid serious heed to these accessories, save for convenience of shorthand statement.

A symbol of great importance in the history of the art is the famous "Philosopher's Egg." An egg naturally suggests life, and was therefore widely used to designate the principle of fecundity on the source of it. The "primitive" egg was adopted among the Chaldeans, the Persians, the Hindus, and the Chinese. Egypt had its egg of Osiris in which the god had enclosed two white pyramidal figures, symbols of the good things with which he would dower mankind.

His brother, Typhon, introduced twelve black pyramids, symbols of the ills which were to afflict and destroy. Another Egyptian legend tells how Khoum, desiring to create, put forth from his mouth the egg of the universe. He is often represented as fashioning on a potter's wheel the mysterious oval from which were to come the human race and the whole of nature.

The alchemist's egg symbolised this range of notions; but in addition it was taken to signify the special work of the Hermetic art. In an early manuscript it is thus described: "The ancients call the Egg the Stone of copper, the Stone of Armenia, the Stone of Egypt. Others call it the Image of the world. Its shell is of copper, the alloy of copper and lead, the alloy of iron and copper. The calcined shell signifies chalk, arsenic, sandarac, Chian earth, etc. The liquid parts of the Egg are the rust of copper, the water of green copper. . . . The white of the Egg is called gum, juice of the fig, juice of the euphorbia. The yellow of it is called mineral of solid copper. . . . Attic ochre, Cilician safran." * Thus did imagination, when given free rein, elaborate fancies intended to invest the art with high mysteries. The application of the symbol in laboratory operations will find mention later.

Yet another symbol of prime importance is the mystic serpent, or dragon, which bites its own tail. This too was widely known in the ancient world, and was connected with the doctrine that in nature there is a constant round of recurrent changes. The alchemists, while retaining its original significance, applied it with special reference to their own work,

* Quoted by Berthelot, *Les Origenes de l'Alchimie*, p. 24.

which they conceived, in its larger aspect, to have neither beginning nor end—imitating, as they maintained, a universal natural process. They also used it as a symbol for the "moist" principle, without which nothing can exist: of the soul of the world which gives birth to, and envelops all that has being —the starry sky which surrounds the planets, the beauty and harmony of the universe. The symbolism thus practically coincides with that of the Philosopher's Egg. Sometimes it is pictured with three ears which represent the three vapours; and with four feet which represent the four fundamental substances or metals, lead, copper, tin, and iron. These last details recall the mysterious salamander which can live in the fire.

Magic Formulas.

Many and interesting are the formulas and symbols found in the ancient manuscripts. One of the oldest is the *Mappæ Clavicula*,* containing very varied material. By the use of a certain figure (not preserved in the manuscript, but probably that distinctive of the metal, lead) you can work wonders. You can make a well run or stop running; a cup will hold or lose its liquid; a cask will empty itself; and so on. By its virtue applied to a lantern and its oil, a phantom will come out of the house and enter it again; soldiers will come out of their camp without their lances. Then comes a description of the concentric circles of Cardan in which a suspended vase will never upset.

* See p. 178.

In a Greek manuscript which is very ancient we find the formula of the Scorpion, the Labyrinth of Solomon (a Kabalistic design), an astrological sphere, teachings of Nicephorus on the art of interpreting dreams, the prognostics of the four seasons, magical alphabets, the Philosopher's Egg. In another ancient treatise, mixed up with chemical receipts, are tables to calculate the life or death of a sick man, a formula for bringing about the separation of a man and his wife, another to cause insomnia to a man until he dies of it, a philtre to excite friendship, composed of plants, minerals, and magic letters. Thus closely were astrology, magic, and chemistry uncritically intermingled in the same treatises, and regarded as being really connected.

Varying Strength of the Magical Element.

In the treatises of the Greek adepts magical formulas are mingled with practical. But they decrease in number as the art develops. Michal Psellus * definitely affirms that the destructions and transformations of matter have natural causes and are not influenced by incantations and secret formulas. We must make allowance, however, for the fact that in the Middle Ages many things which offended the prevailing sentiment were purged out of the old manuscripts. The magical element may therefore have been greater than it appears. Broadly speaking, the Arabians were dominated by a scientific spirit which kept magic in the background. Quotations

* See p. 86.

given in the historical section will afford evidence of this subordination.*

Though the Middle Ages purged out many of the older and less acceptable formulas, they eagerly developed a new magic of their own, and sought for means, hallowed or unhallowed, to coerce the wills of demons and angels. Alchemy became an art that hovered between the black magic of the sorcerer and the white magic of the Church. Even such men as Arnold of Villeneuve and Basil Valentine† took astrology and magic seriously, and prepared the way for the extravagances of Paracelsus. Arnold, in his treatise *De Sigillis*, gives a number of formulas against demons, and Valentine threw himself enthusiastically into the cult of Hermetic mysticism. It remained for Paracelsus and the Rosicrucians to overwhelm the art with absurdities. In the *De Tinctura Physicorum* Paracelsus commits himself to this drastic statement: "Unless thou understandest the usages of the Cabalists and of the ancient astrologers, God has not created thee for the spagyric‡ art, and Nature has not chosen thee for the Work of Vulcan."

An Animated Statue.

An extraordinary, but characteristic story is told of Albertus Magnus and his pupil, Thomas

* See p. 29.

† See p. 119.

‡ Spagyrism is a Paracelsian synonym for the Chemistry of separating and combining the principal constituents of substances. It was specially applied by this school to the compounding of medicines. The art included, of course, the analysis of metals and the search for the Philosopher's Stone.

Aquinas. It was said that the master had got possession of some portion of the Elixir of Life. With this he succeeded in animating a brazen statue which, under proper conjunctions of the planets, he had made with immense toil. He and Aquinas completed it together, endowed it with the faculty of speech, and condemned it to undertake various duties, domestic and other. It acquitted itself excellently and proved itself a most useful servant. But owing to some defect of construction (wrong planetary influence!) its power of speech unduly asserted itself, and its chattering became a nuisance. The two adepts tried all sorts of remedies, but in vain. One day while Aquinas was struggling with a mathematical problem, he was so irritated by its untimely garrulity that he seized a hammer and pounded it to pieces. It repented him sorely that he had allowed his temper to work such dire mischief, and Albertus severely reproved him for the outburst. It appears they made no attempt to repair the statue; at any rate it was no more heard of.

We cannot imagine that such men would lend their countenance to the idle tale. Nevertheless the mere fact that it was invented and found credence is evidence of the lengths to which popular credulity could go, and reveals the atmosphere in which alchemy then flourished. But Aquinas himself was not able to throw overboard all belief in magic, as is shown by his distinction between the white and the black.*

* See p. 34.

Palliation.

That the quest of the Philosopher's Stone was always accompanied in greater or less degree by a belief in magic cannot be denied, though, as was before urged, the place it filled was not nearly so large as is generally thought. What shall be said on this count in defence of the alchemists? In answering the question, we must confine ourselves to the case of those who were honest inquirers and thinkers. Rogues and charlatans do not merit apologies, in whatever age they may appear.

The outstanding palliation was the fact that during the whole development of the art (save for the reaction in the last stage) the pseudo-sciences of astrology and magic were almost universally accepted without criticism. If alchemy is to be condemned because it did not rise superior to their prestige, it must share the blame with the Christian Church itself. This consideration seems to meet the case without further pleading. Why the prestige should have been so great and so lasting is another matter which would call for special treatment. The fact remains.

Further, let us ask ourselves what is our own position in this regard. It is true that the enormous expansion of our knowledge of nature and her ways has altered our outlook, and has liberated us from the sway of many foolish or harmful creations of men's fears and vain imaginings. Magic is now a harmless thing—the means used by conjurers to amuse and mystify. And yet, even in our enlightened Western

civilisation, how strong is the hold which the fascination of the uncanny and the occult retains—and that, not only on the minds of untrained thinkers, but of the educated and the scientific! No, the twentieth century has not yet won the right to cast the first stone at those who, in ages of dim knowledge, yielded to the pressure of the conceptions ruling in their world of thought. Rather must we keep undulled the edge of our gratitude to the adventurous pioneers who had to throw off the load of superstitions, and who blazed a track for others destined to enjoy fuller truth and wider liberty.

PART III

THE OBJECTS OF THE QUEST

CHAPTER I

THE PHILOSOPHER'S STONE

HAVING gained a general idea of the history of alchemy, and of the main conceptions, philosophical and other, on which the art was based, we are now in a position to come to closer quarters with the definite aims and practices of the adepts. We shall first consider the Philosopher's Stone, the Elixir of Life, the Universal Solvent, their supposed properties and powers, and the claims made to have discovered them. The materials and the methods employed will have separate consideration.

WANTED—A TRANSMUTING AGENT.

The idea of, and belief in, the possibility of transmutation have been explained and expounded in the preceding part. They render the alchemist's original and master problem sufficiently plain. Given the possibility of transmutation, how can it be effected? More particularly, how can the baser metals be transmuted into gold? The earliest alchemists, as we saw, had adopted the philosophical doctrine of a "first matter" out of which all the various substances in existence were constructed. They argued from this that there must be some fundamental form

of substance which is possessed of perfect qualities, and therefore of special virtues. They gave to it many names of more or less vague connotation—the Grand Magisterium, the Elixir, the Tincture (the Dyer), the Quintessence, and others yet more strange and fanciful. This, they held, when combined with other bodies would act powerfully upon them; in the case of the imperfect metals, it would purify and vivify them, and change them into the perfect metal, gold.

To this idea of a transmuting substance was generally added that of its generating power. Its action was regarded as being akin to that of a seed which sets going a process of development, and as being a necessary means to the genesis of the perfect metal. We here have an explanation of the term "the philosophical egg," used of the furnace in which the fecundation was supposed to be effected, the symbolism of which has been adequately described above.

Early Descriptions of the Agent.

The early alchemists had no clear or settled idea what this substance might be. They used various methods to find it, and looked for it in various places. They did not regard it as exclusively mineral, but even made use of organic bodies in its preparation—blood, hair, egg, and so forth. The majority of the Greek and Arabian authors contented themselves with establishing theoretically the fact of transmutation without venturing to specify any particular agent for effecting it. Geber was an exception, and

set himself to work to discover and make it. Here is a description of it from the Third Book of an Arab treatise called the *Book of Ostanes*. "Know, O Seekers, that it is a white water which one finds buried in the soil of India; a black water which is found buried in the country of Chadjer; a red brilliant water which is found in Andalusia. It is a liquid which is fired by stones in the countries of Persia; it is a tree which grows on the peaks of the mountains; it is a young man born in Egypt; it is a prince coming from Andalusia who seeks for the torment of the seekers." The last of these descriptions would seem to be the truest, if these mystical phrases are to be used as guides to discovery; for certainly they would ensure "the torment of the seekers."

Another yet more curious set of descriptions from the same treatise. The master substance is running water—water of eternity—burning fire—the fire which thickens—the dead earth—the hard stone—the soft stone—the fugitive—the fixed—the generous—the rapid—that which puts to flight—that which fights against fire—that which kills by fire—that which has been killed unjustly—that which has been taken by violence—the precious object—the object without value—the dominant glory—the infamy made vile. It would seem that the imagination of the author ran riot in piling up oppositions and antitheses. May we take his meaning to be that the Quintessence is at once devoid of all specific qualities, and yet potentially possesses them all? Looked at from this point of view, there is something Hegelian in the rhapsody. Or again, we may interpret from what may be called the subjective standpoint. For instance, the

Quintessence is dear and glorious to him who knows it and uses it, vile to him who is ignorant of it; finite and specific for the one, infinite and indeterminate for the other. In any case it is plain that the author himself had not discovered it. He is merely writing about it, keenly determined to exalt its virtues and create an atmosphere of mystery.

Other adepts, of a more positivist turn of mind, tell us it is mercury, or gold; but they are careful to add that we must not think of these metals as we ordinarily have them. "Supplement (says one) your common mercury with the inward fire which it needs, and you will soon get rid of its superfluous dross." "The agent is gold (says another), but gold that is as highly matured as natural and artificial digestion can make it, and a thousand times more perfect than the common metal of that name." As a sort of corollary to this distinction, we are told that if the transmuting agent has not been brought to the highest degree of purity, it will only change the common metals into silver, not into gold. Others advanced the opinion that there were really two different kinds of the agent—the Grand Magistry and the Little Magistry; the former being needed for the production of gold, the latter only capable of ennobling a metal as far as the stage of silver. All such statements are necessarily vague and illusive, especially when we try to harmonise them with the doctrine that metals grow—that is to say, develop continuously from stage to stage. Nevertheless we recognise throughout the influence of philosophical presuppositions which supply a rational basis for even the most rhapsodical and mystical of these speculations.

The Stone.

The most famous of the names given to the transmuting substance—the Philosopher's Stone—is first heard of in the twelfth century. The word "Stone" must not be taken in its strict sense, but rather as equivalent to the more abstract term "substratum" —the something which underlies and supports. It was applied to any substance—powder, liquid, solid —that was supposed to have the magisterial power of transmuting. The emergence of this definite name implies that purely theoretical descriptions were giving place to more practical attempts to define the nature and properties of the much-sought-for wonder-worker. Zosimus, the oldest extant author on alchemy, keeps to the early style in his description of it. "In speaking of the Philosopher's Stone, receive this stone which is not a stone, a precious thing which has no value, a thing of many shapes which has no shapes, this unknown which is known of all." And again, "Its kind is one, its species multiple. All comes from the One, and all returns to it. . . . Here is the Mithriatic mystery, the incommunicable mystery." But in strong contrast with this antithetical rigmarole, we have express assurances that the Stone has been seen and handled.

Descriptions of the Stone.

It is usually described as a red powder. Lully mentions it under the name of Carbunculus. Paracelsus presents it as a solid body of the colour of a

ruby, transparent, flexible, and nevertheless breaking like glass. Van Helmont writes: "I have seen and handled the Stone. It had the colour of saffron in powder; it was heavy, and brilliant as glass broken into bits." Berigard de Pisa, who saw it in the transmutation which an unknown adept effected for him, is very precise, telling us it is the colour of a poppy and smelling like burnt sea-salt.* Helvetius gives it the colour of sulphur. In short, the descriptions are as diverse as they are numerous. One author, Kalid, is determined to be comprehensive, and to reconcile the contradictions. He says the stone unites in itself all the colours.† It would seem that, after such specific experiences as these, the Stone should have been a real object with known and proved properties. And yet, after all, no such substance ever has been, or ever will be, known!

As a specimen of longer descriptions we may take this from Philalethes in his *Brief Guide to the Celestial Ruby:* "The Philosopher's Stone is a certain heavenly, spiritual, penetrative, and fixed substance, which brings all metals to the perfection of gold or silver (according to the quality of the medicine), and that by natural methods, which yet in their effects transcend Nature. . . . Know then that it is called a stone, not because it is like a stone, but only because, by virtue of its fixed nature, it resists the action of fire as successfully as any stone. In species it is gold, more pure than the purest; it is fixed and incombustible

* "Colore non absimilis flore papaveris sylvestris, odore vero sal marinum adustum referentis."

† "Lapis iste habet in se omnes colores. Est enim albus, rubens, rubicundissimus, citrinus, citrissimus, celestinus, viridis." Quoted by Figuier, from whom most of the above references are derived.

like a stone, but its appearance is that of a very fine powder, impalpable to the touch, sweet to the taste, fragrant to the smell, in potency a most penetrative spirit, apparently dry, and yet unctuous, and easily capable of tinging a plate of metal. . . . If we say that its nature is spiritual, it would be no more than the truth; if we described it as corporeal, the expression would be equally correct." We find in this passage a curious blending of the old antithetical mystical statements with details which the author had somehow or other persuaded himself belonged to the world of material facts. Yet the substance described is as unreal as the mysticism is impalpable. It is difficult to guess what was actually in the minds of adepts who could be thus circumstantial.

Measure of Potency.

Assuming, as these alchemists did, that the Stone actually existed, and that it possessed the transmuting power attributed to it, a question naturally arose as to the extent of its potency. How much common metal could be changed into gold by any given quantity of the wonder-worker? We saw how the last of our English adepts, Dr. Price, sheltered himself from being put to the test by declaring that his stock of the transmuting material had run out, and that it would require a long time to prepare more. Clearly, then, in the latest stages of the art the claims made in this regard were modest—not too remote from the sphere of scientific experience. But it was not always so. Figuier provides us with a beautiful *crescendo*.

He tells us that in the Middle Ages the pretensions were far more ambitious. Arnauld de Villeneuve declared that the Stone could convert a hundred times its own weight; Roger Bacon said a thousand times; Isaac the Dutchman, a million times. Raymond Lully was not content with this last estimate, generous as it was. He held that not only could the Stone change mercury into gold, but it could also give to the gold thus formed the virtue of playing the *rôle* of that which had converted it. This view is not quite so beside the mark as Figuier seems to think. For if, as was often supposed, the action of the Stone was of the nature of a ferment, its effects would be unending provided the necessary conditions could be fulfilled—as in the case of the continued production of yeast. ("Ferment" theories, by the way, are coming into fashion again in solving problems of advanced biology and physics!) The really fatal objection, of course, is that the Stone could not be a ferment because it did not exist. Lully, however, had not arrived at this conclusion, and boldly exclaimed that he would transmute the ocean, were it mercury.* Another alchemist, Salmon, took the final step, and asserted that the transmuting power of the Stone was infinite.

Healing Powers.

It was only to be expected that an agent of such mystic potency should be thought capable of doing much more than transmuting common metals into gold. A simple extension of this most prominent

* "Mare tingerem si mercurius esset."

virtue was that the Stone could make, artificially, precious stones, such as diamonds, pearls, rubies. A more singular claim was that it could revive dead trees. And this brings us naturally to a new and wider range of notions which flourished exceedingly in the Middle Ages, and in the later stages of the art. Wealth was an object of anxious longing—but so also was health. And it came to be an almost universal belief that the Stone could be used as a panacea for bodily ills, and could extend the term of life. We here touch upon one of the philosophical elements in alchemy. We recall how that the "First Matter" was held to be, in its essence, the soul of the world—the spirit constituting the ultimate reality of all substances and existences in nature, including man. Small wonder, then, that the Philosopher's Stone, so akin to this spirit, if not the spirit itself, should come to be credited with life-giving virtues.

Boerhaave has suggested a further explanation of this development. Geber, the Arabian, in one of his works, speaks thus: "Bring me six lepers that I may heal them." He means, "Bring me six common metals that I may transmute them into gold." Now the judicious historian of chemistry suspects that the idea of a universal medicine had its origin in a misunderstanding of these words. They were interpreted literally. However this may be, the healing power thus attributed opened out a wider career for the Stone. It first receives notice in the thirteenth century. In the fourteenth and fifteenth centuries, it was gravely prescribed as of sovereign efficacy—taken interiorly, the most precious of all medicines. Let Denis Zachary set forth the manner of its use: "To use our grand king

(the Stone) for the recovery of health, it is necessary to take a grain-weight and to dissolve it in a silver vessel with good white wine, which it will turn to the colour of citron. Then let the patient drink a little after midnight, and he will be healed in a day if his malady is a month old; if the malady is a year old, he will be healed in twelve days; if the malady is of longer standing, he will be healed in a month by using it each night as above prescribed. And to keep always in good faith, it is necessary to take it at the beginning of the autumn and the beginning of spring after the manner of a syrup. And by this means the man will live always in perfect health to the end of the days that God shall have granted him, as the philosophers have written."

Note the last clause—"to the end of the days that God shall have granted him." This is modest. And no doubt faith in the remedy would go far to justify the statement. Isaac of Holland and Basil Valentine say pretty much the same things as Zachary, with subsidiary variations. But others were not so cautious. Artephius, for instance, put the limit of human life, thus fortified, at a thousand years. Other adepts brought in as evidence the prolonged lives of the Patriarchs, assigning as a cause the use of the Stone. As mentioned in an early chapter, Noah was especially a favourite in this regard because he begat children in his old age.

Mental and Moral Properties.

But the keener spirits demanded more than the medical properties. If the Stone was essentially akin

to the soul of the world, it must possess still higher virtues. It must have an influence on man's mind as well as on his body. The fortunate user could secure wisdom, enlightenment of understanding, heightening of all his faculties, strengthening of his moral nature, acquisition of positive virtues. As it ennobled the metals, so it lifted the whole man on to a higher plane. Salmon writes: "Those who are happy enough to have possession of this rare treasure, however wicked and vicious they may have been, are changed in their manners and become good people; so that no longer deeming anything on earth worthy of their affection, and having nothing to desire in this world, they sigh for nothing but God and for eternal happiness." Norton writes: "The Philosopher's Stone brings to each succour in his needs; it rids man of vain glory, of hope and of fear; it takes away ambition, violence, and excess of desires; it sweetens the hardest adversities. God will place among His saints the adepts of our art."

The concluding sentences in these two quotations introduce to us a further set of speculations which shall be treated of in the next chapter. So far as we have gone, we may fairly conclude that, in spite of much that appears to us eccentric or absurd, the search for the Philosopher's Stone presents aspects well worthy of our approval, if not our admiration. Granted that the desire for wealth was in most cases the dominating motive, it was by no means the only motive—there were cases not a few where it was the subsidiary motive. The noble sort of adepts aimed at satisfying man's intellectual, moral, and religious aspirations. One of this nobler sort exclaims, in the

spirit of Moses or of a Christian Apostle—"Would to God . . . all men might become adepts in our art; for then gold, the common idol of mankind, would lose its value, and we should prize it only for its scientific teaching."

CHAPTER II

THE STONE AND MYSTICISM

HAVING taken a general view of the objects aimed at in the search for the Philosopher's Stone, and considered its supposed properties and powers, let us go into further detail concerning what may be broadly called its "mystical" aspects. During the Arabian period, these were not prominent. The Semitic mind does not easily lend itself to abstract speculations, but prefers to keep close to the concrete. In modern terminology, we should call it "positivist." Nevertheless in the Arabian treatises, we find many passages that contain matters far removed from the world of fact—fanciful allegories—purposely obscure statements—a decided vein of mystery. In the *Book of Ostanes*, for example, poor Aristotle is credited with this description of the Stone: "It is a lion reared in a forest. A man has desired to use it for a mount and has put on it a saddle and bridle. Vainly he tries and cannot succeed. He is then reduced to trying a more clever stratagem which allows him to keep it in solid bonds and to put on the saddle and bridle. Then he conquers it with a whip, with which he deals it grievous blows. Later he looses it from its bonds and makes it march like an ordinary creature—so completely that one would

affirm it has never been savage a single day." The Arabian author's comment is this: "The stone is the lion; the bonds are the preparations; the whip is the fire. What say you, O seeker (he triumphantly asks), to a description so close?" The readers of these treatises are not always favoured with a key to these allegories! Even with the key, things are a little vague. But we gain a good idea of the anthropomorphising, emotional, and mystical spirit in which the alchemist prosecuted his researches. Nature, for him, was alive; and the properties of substances were regarded as beings with wills which had to be subjugated.

The following passage from the same treatise manifests yet more clearly this characteristic attitude. The object of the search apostrophises the seekers. "O troop of seekers, take me, slay me. Then, having slain me, burn me; for I will after all revive, and enrich him who shall have slain and burnt me. If he comes near me with fire, then I am alive. If I shall endure it all the night, even if he sublimes me completely and enchains me in an absolute fashion, (I am still alive). O marvel! How, being alive, can I bear ill-treatment? By heaven! I will bear it until I am watered with a poison which will kill me, and then I shall no longer know what the fire has done to my body."

Compare these allegories with a collection brought together by the author of *A Brief Guide to the Celestial Ruby*—a treatise written when the art was entering on its decadence. (The Essence) "is our door-keeper, our balm, our honey, our oil . . . may-dew, mother, egg, secret furnace, oven, true fire, venomous dragon,

Theriac, ardent wine, Green Cion, Bird of Hermes, Goose of Hermogenes, two-edged sword in the hand of the Cherub that guards the Tree of Life. . . . It is our true secret vessel, and the Garden of the Sages in which our sun rises and sets. It is our Royal Mineral, our triumphant vegetable Saturnia, and the magic rod of Hermes by means of which he assumes any shape he likes." We note how that the old simple intensity has degenerated into a wayward, artificial, play of imagination. The author almost flogs himself into mystical contortions; and, save for minds similarly constituted to his own, lamentably fails in producing the effect he aims at. The Rosicrucians carried this development to such a height of absurdity that the system toppled over by its own weight.

Religion and Alchemy.

Between the Arabian period and the decadence came the Middle Ages—the times in which mysticism took a highly peculiar form, as a consequence of its being moulded to fit in with a special set of theological ideas and standards. It was taught, by many adepts, that the Stone was given to Adam by God Himself; that the secret of it was known to the Patriarchs, Solomon, and other Old Testament personages; and that it is "the white stone" promised in the Book of Revelation "to him that overcometh." That is to say, alchemists tried to incorporate their doctrines into the body of beliefs promulgated by the Church. Arnold of Villeneuve is very bold: "Know, then, my dear son, that this

science is nothing less than the perfect inspiration of God."

The alliance of alchemy with religion was, as has been shown in earlier chapters, in itself no new thing. Geber, for example, exclaims: "Courage, then, sons of science. Seek, and you shall infallibly find this most excellent gift of God which is reserved for you alone." The connection, however, is comparatively simple; and, indeed, superficial, in the sense that religion was not mingled with science, except as inspiring and guiding it. Whereas in the Middle Ages, little by little the prevailing religious ideas were worked into the very texture of alchemical doctrine and practice. To illustrate the extent to which such alliance could develop, take the following passage from Basil Valentine's *Allegory of the Holy Trinity and the Philosopher's Stone*:—

"Dear Christian amateur of the blessed art, oh! how the Holy Trinity has created the Philosopher's Stone in a brilliant and marvellous manner! For God the Father is a Spirit, and He appeared, however, under the form of a man, as is told in Genesis; in the same way we ought to regard the Philosopher's Mercury as a body spirit. Of God the Father is born Jesus Christ, the Son, Who is at the same time man and God, and without sin. He had no need to die; but He died voluntarily, and rose again to make us live eternally with Him as His brethren without sin. Thus gold is without stain, fixed, glorious, and able to undergo all tests; but it dies for its imperfect and sick brethren; and soon, rising glorious, it delivers them, and colours them for life eternal; it renders them perfect in the state of pure gold."

In judging such a statement as this, we must be careful to put ourselves at the standpoint of its author. In the first place, we must remember that, for him, "the perfect metal" was, in its essence, the soul of the world, the Spirit that underlies all modes of existence. Again, the more earnest of the adepts, especially in religious houses, were wont to enter on their operations with prayer, thus giving them a definitely religious atmosphere and significance. We can realise, therefore, that the object of so many hopes and vows, of so much mystical exaltation, should come to be regarded as sacred and divine. Attempts to read into alchemical doctrines certain fundamentals of Christian belief are thus seen to be natural products of a peculiar combination of conditions, and we judge them accordingly.

Death and Resurrection of Metals.

We saw, in dealing with the philosophical basis of alchemy, that distinctions between the body and the soul of metals led on to notions of their death and resurrection. This line of speculation easily lent itself to analogies with religious doctrines. We find the connection even in the Arabian treatises. Thus, in the 71st section of that named *The Book of Pity*, we read as follows: "The souls and bodies (of metals), when they unite and are transformed to become a homogeneous whole which cannot be divided, have been compared to the dead which God will raise on the day of the last judgment. Souls are joined to subtilised bodies which will never more die, and that

because light spirits are joined to bodies equally light. Moreover, their place will be fixed, either in an eternal happiness which will endlessly renew them, or in a grievous chastisement which will increase without ceasing. After this, the spirits will be no more separated from the bodies, as they were in this world, where spirits are simply in contact with bodies, without being intimately combined with them. It is this contact of neighbourhood that, in the current speech, is called 'mixture.'"

This assimilation of the transmutation of metals to the death and resurrection of men became quite common in the Middle Ages. It is curious and unexpected to be told that it was highly pleasing to Luther. It gained his support for the art, which on this score he praised in strong and enthusiastic terms. The notion was advanced to a yet higher stage when it was assumed by some that the resurrection of men's bodies would itself be, literally, an alchemical change, a transmutation of a superior order. Thus whole-heartedly did the alchemists strive to give their art a universal and cosmical bearing.

The Grand Secret.

The pursuit of the Hermetic art maintained in no small degree its mystical character by the jealous care with which it guarded the secret of the Philosopher's Stone. This secrecy had its origin in the Egyptian workshops, where receipts for making alloys and falsifying the precious metals were handed down from generation to generation of the operators, who were generally priests and so members of "close

corporations." A very early manuscript, the contents of which date back to the tenth century, gives a receipt for making "excellent gold," and adds, "Hide this sacred secret which ought not to be disclosed to any one, nor given to any prophet." * The warning would seem to be a mixture of trade caution and alchemic mysticism. Berthelot shows that it had an Egyptian origin. We have several times seen that even the ordinary working of metals was commonly thought to savour of the supernatural. It was therefore to be expected that the metal art *par excellence* would gradually be invested with a mystic halo. A remarkable passage of Byzantine origin, dating back to the eighth century, introduces a Gnostic element. "The philosophers, being gathered together in the presence of Mary, said to her: 'Happy art thou, Mary, for the divine secret has been revealed to thee.'" † We here have a germ thought from which many developments might be anticipated. The term "the Secret Stone" is frequently met with in these ancient alchemical documents, and even by itself contains a world of significance.

The occult turn thus given to alchemical operations is expressly recognised in one of the Leyden manuscripts in a treatise attributed to Aristotle. "This art speaks of occult philosophy. To succeed in it there must be a knowledge of interior and hidden natures." ‡ In the seventeenth century there were works which were definitely entitled *The Book of*

* *Mappæ Clavicula*, Section 14.
† See Berthelot, *La Chimie au Moyen âge*, vol. i, p. 243.
‡ *Op. cit.*, p. 312.

Secrets. How the Rosicrucians developed the occult elements need not be further described after what has been said in the historical sketch.

How much in earnest the early alchemists were in guarding these secrets is shown in this quotation from another of the Leyden manuscripts: "He (Ostanes) commands that no one shall dare to alter his books . . .; he commands every one and prescribes that his words shall in no wise be made known to the vulgar. He puts out terrible oaths in order that they may be revealed to none, unless it be to a worthy person, or one who seeks the truth and loves God," etc. . . . This is why philosophers have changed the language in their words, and have substituted one sense for another, one passage for another, one species for another, one vision for another.* That this is no misrepresentation of the teaching of the *Book of Ostanes* is proved by this passage from the book itself: "These men have defended the secret of the Stone at the point of the sword, and have abstained from giving it a name, or at any rate have given it a name under which the crowd may know it. They have disguised it under the veil of enigmas, so that it has escaped even penetrating spirits, and so that the most lively intelligences have not been able to comprehend it, and hearts and souls have despaired of knowing its description. There are only those whose understanding God has opened who have understood it and have been able to make it known." How well these obscurantists succeeded in their endeavours will be abundantly proved in a later chapter when we come to consider the interpretation of their formulas

* Berthelot, *La Chimie au Moyen âge*, vol. iii, pp. 326–7.

and receipts! Their task, however, was not so difficult as it might appear. There was, in reality, no secret to hide—at any rate no secret for making the Philosopher's Stone. What they had really to conceal was the fact of their failure to attain their supreme object. Nevertheless we see how they revelled in the sphere of the mystical and the occult.

Summary of the Chief Characters of the Stone.

Putting together what has been said in this and the preceding chapter, we may emphasise the following points. The whole series of notions concerning the Philosopher's Stone are founded on a basis provided by ancient doctrines concerning "the First Matter" and the life that pervades all the substances composing the known world. They can thus claim to be so far rational. The primary object of the art was the acquisition of wealth by transmuting common metals into gold. The occult virtues attributed to the instrument for effecting transmutation—the Stone—led to an extension of its area of action. It came to be looked on as a universal panacea for human imperfections. It could give health, heighten the faculties, ennoble the character, prolong life. It could bring men into touch with the soul of the world, and thereby enable them to hold communion with spiritual beings and live on a higher plane of being. Its modes of working could be compared to, or connected with, the mysteries of the Christian religion. These were indeed adequate grounds for naming it the Grand Magisterium, and for holding the means of procuring it to be the Grand Secret.

CHAPTER III

CREDULITY AND IMPOSTURE

HITHERTO attention has chiefly been concentrated on the beliefs, aims, and practices of honest, though often deluded, searchers for that undignified and undefinable substance, or essence, which should fulfil their large and comprehensive hopes. There has been no attempt, however, to disguise the fact that the art has been continuously turned into folly by credulity, debased by superstition, and degraded by impostors. Let a chapter be devoted to this shady side of our subject. We can then enter, without further mention of aberrations and follies, on the study of its scientific aspects.

The Secret Elixir.

Ben Jonson makes his alchemist speak thus :

> "He that has once the Flower of the Sun,
> The perfect ruby which we call Elixir, . . .
> Can confer honour, love, respect, long life,
> Give safety, valour, yea, and victory,
> To whom he will. In eight-and-twenty days
> I'll make an old man of fourscore a child."

Here is the language of a charlatan, who could not help knowing that his claims were vain and foolish.

So, too, with Donsterswivel's rhodomontades in Scott's *Antiquary*. We know where we are. But what do we make of such a case as this?

In the *Book of Geber*, the writer gives directions for concocting the Elixir. "Take away that which is strange, . . . take away its corporeal and material form; for it will not be able to mingle itself with the subtle portions unless it is subtle itself. . . . Combine the cold and humid elements at first with the warm and humid, then with the warm and dry, and you will have the *Imam* (the Elixir). . . . Keep it in a vase of rock-crystal, in gold or in silver, as glass may be broken." Thus far we may suppose the writer may be speaking in that mixed frame of mind which confuses fact with fancy. But he proceeds thus: "I have hidden nothing from you, I have made plain all difficulties, in a way that no ancient or modern has done. Reward me with your prayers. Distribute a part of the Elixir in my name gratuitously to the poor and the miserable. God will repay you on my behalf. It is He Who suffices me, and is my best of protectors." This is very puzzling. The terms in which the directions are given are so vague and symbolical that no one could make anything of them. Yet the claim to have succeeded is clear, and the piety of the concluding sentences seemingly sincere. Did the writer mean it?—or was he a charlatan? Perhaps he is a member of that strange class of people who, in consequence of long and hard willing and reflecting, at last come to believe that their fancies are facts. If we grant him the benefit of the doubt, his case might be paralleled in every period of the alchemic art. Before indulging in

condemnations, we must make generous allowance for the influences of environment and the vagaries of temperament.

The Alkahest.

Van Helmont's belief in the discovery of the Universal Solvent, called by Paracelsus the Alkahest, affords another striking instance of over-credulity. He enthusiastically took up the idea that this solvent could give to bodies of every kind a liquid form, and in his works he gravely retails all the absurdities that charlatans had promulgated concerning its powers. This treasure, he tells us, was committed to him by an unknown adept. Unfortunately he was not able to keep it long; but he assures us in the most categorical fashion, that he had actually proved its efficacy. "Having put some oak charcoal and alkahest, in equal parts, into a glass vessel sealed hermetically, I caused this mixture to digest for a period of three days at the heat of a bath. At the end of this time the solution was completed," etc. What is behind all this? Certainly not the Alkahest! And yet Van Helmont was honest. Perhaps we may compare his experience to that of certain modern savants who have borne testimony to occult phenomena which were afterwards shown to be due to trickery.

However this may have been, Alkahest, in the seventeenth century, and for a considerable part of the eighteenth, had a considerable vogue. Boerhaave says that a library could be formed of the treatises written about it. Many boasted that they had discovered it, or obtained it. And there is no telling how long it

might not have maintained its reputation, had not a critic pointed out the simple reflection that if the solvent really existed, it could not be stored or used; for it would dissolve the vessels in which it was contained!

Rejuvenation.

In Ben Johnson's Masque, *Mercury Vindicated from the Alchemists*, Mercury *loquitur*: "They will calcine you a grave matron, as it might be the mother of the maids, and spring up a young virgin out of her ashes, as fresh as a phœnix; lay you an old courtier on the coals, like a sausage or bloat-herring, and, after they have boiled him enough, blow a soul into him with a pair of bellows." This is hardly a travesty of what had been popularly believed of the powers of the greater adepts; nor were certain of these adepts themselves slack in stimulating such delusions. Artephius, for example, who lived early in the twelfth century, and who made for himself a famous name, affirmed that, when he wrote his treatise on the art of prolonging human life, he was in the thousand and twenty-fifth year of his age. Many accepted his statement, and were confirmed by the skill with which he answered questions concerning what had happened to him at various times in this prolonged span.

We have a glimpse of the manner in which such ideas may be suggested, and take root, in the story of Alain de Lisle. He was a man of great learning, contemporary with Albertus Magnus, and became a friar of the abbey of Citeaux. He died in 1298 at

about the age of a hundred and ten years. Now it happened that when he was in his fiftieth year, he had a severe illness, from which he recovered. He was reputed to have discovered the Elixir; and the recovery was straightway attributed to this marvellous medicine. How far the sage acquiesced in this conclusion, or how far he encouraged it, we do not know. But at least we can trace, in this instance, the origin and ground of the fallacy.*

Akin to the rejuvenation idea was that of palingenesis—the art of making plants spring afresh from their ashes. Figuier suggests † that this probably had its origin in a natural phenomenon. When the ashes of certain plants are dissolved in water, the solution, left to itself, deposits crystals of which some may take the form of an arborescence. We may readily accept the suggestion. But it does not excuse the bare-faced impostures that in the seventeenth and on into the eighteenth centuries, were based upon the experience. It is not inapposite to compare the Indian trick of the mango-tree, if the plant produced by the alchemist conjurors were at all speedy in its growth. If the development were slow, by sprouting from seed, the trick becomes absurdly easy.

False Transmutations.

We have seen that alchemy had its origin in the metal work of the Egyptians, and have noted that

* I have taken the two stories from Mackay's *Extraordinary Popular Delusions*, in which the lives of the chief alchemists are racily told.

† *L'Alchimie*, p. 66.

the uttering of false coinage and the debasing of gold were common practices dating from ancient times. The rise and development of a distinct art of transmutation gave peculiarly favourable openings for frauds which would in any case have flourished lustily. The story of alchemy is, of course, full of impostures of this kind. Moreover, there was a new spur to deception. For when an alchemist had professed to be able to make gold, and was put to the test by some authority, political or scientific, he was tempted to pretend to make it. Chaucer, in his *Canon's Yeoman's Tale*, shows us how, even in his date, the art had gained a bad reputation. The tale is well worth careful reading for the picture it gives of mediæval alchemists and their methods, true and false. The false is to the fore. The impostor canon

> "Out of his bosom took a beechen cole,
> In which ful subtilly was maad an hole.
> And therein put was of silver lymale
> An unce, and stopped was withoute fayle
> This hole with wex, to kepe the lymail in."

This is slipped into the croslet in which the quicksilver is heated. The poor priest knows nothing of the trick being played upon him, and concludes that the silver is the result of the action of the powder on the quicksilver. Chaucer's indignation is hot:

> "Ever when I speke of his falshede,
> For shame of him my cheekes wexen reede."

Methods similar in principle to this of the false Canon were very common, though requiring more careful preparation. The gold might be found in a

crucible in which large iron nails had been fused; but the nails had been partly made of gold, and the combination skilfully disguised. Or chemicals might be employed which contained the metal in unrecognisable forms. Double-bottomed crucibles, the under surface of iron or copper, the upper of coloured wax, with gold packed in between; holes drilled in lumps of lead, gold inserted, and the opening filled up again with the original metal; and endless like devices. The resources of knaves are inexhaustible, as is also the credulity on which they impose—peculiarly so when the lure of gain puts an edge on the cunning of the one, and blunts what little of calmer judgment may be possessed by the other. So it ever has been, and so it is still. Alchemy enjoys no monopoly in this regard.

Dyer and Kelley.

An amusing dialogue is recounted by Bacon in his *Apothegms New and Old* (262), which gives a lively picture of the conflict between credulity and criticism.

"Sir Edward Dyer, a grave and wise gentleman, did much believe in Kelley the alchymist; that he did indeed the work, and made gold: insomuch as he went himself into Germany, where Kelley then was, to inform himself fully thereof. After his return he dined with my Lord of Canterbury, where at that time was at the table Dr. Browne, the physician. They fell in talk of Kelley. Sir Edward Dyer, turning to the Archbishop, said: *I do assure your grace, that that I shall tell you is truth. I am an eye-witness thereof, and if I had not seen it, I should not have believed it.*

I saw Master Kelley put of the base metal into the crucible, and after it was set a little upon the fire, and a very small quantity of the medicine put in and stirred with a stick of wood, it came forth in great proportion perfect gold, to the touch, to the hammer, to the test. Said the Bishop: *You had need take heed what you say, Sir Edward Dyer, for here is an infidel at the board.* Sir Edward Dyer said again pleasantly: *I would have looked for an infidel sooner in any place than at your Grace's table. What say you, Dr. Browne?* saith the Bishop. Dr. Browne answered, after his blunt and huddling manner, *The Gentleman hath spoken enough for me. Why* (saith the Bishop), *what hath he said? Marry* (saith Dr. Browne), *he said he would not have believed it except he had seen it; and no more will I.*"

Alchemy and Spiritualism.

The fraudulent exploitation of alchemy was so common at all stages of its history that it has preponderantly coloured the popular estimate of its value. We may perhaps draw a profitable parallel between the old art and modern spiritualism. Upholders of the possibility of communication with discarnate spirits, when they are faced with the acknowledged frauds of many mediums, protest that such cases should not prejudice our minds against the larger claims made, or render us unwilling to undertake a dispassionate investigation of untainted experiences. They have right on their side. Whatever our conclusions may be, they should be founded on an impartial weighing of the available evidence.

The Society of Psychical Research devotes itself to a study of such little understood phenomena. Now suppose this Society to have declared itself on the side of spiritualism to the extent of allowing that there is a residuum which calls for serious study, the frauds and deceits would be neglected. To concentrate attention on them would be unreasonable and unscientific. The case for alchemy is much stronger than this. The art has to its credit a long list of discoveries; it has advanced to a considerable extent our knowledge of nature; many of its speculations have a future before them. If we are fair to it, we shall, while laughing at or condemning the charletans, acclaim the successes won by the genuine adepts.

CHAPTER IV

LIFE OF BERNARD OF TRÈVES

AN old Latin estimate of the Hermetic art runs thus: "It is an art without art, which has its beginning in falsehood, its middle in toil, and its end in poverty." We may rather substitute some such estimate as this. Taking it at its best, alchemy was an art to the prosecution of which was devoted a spirit of enthusiasm for the knowledge of nature; it had its beginning in reflection on the causes of chemical actions, its middle in toilsome groping after facts, and its end in the birth of modern chemistry.

We have so far abjured biography save in so far as it directly bore on our subject-matter. Let us for a brief space break through this self-denying ordinance. In justification of the higher and more sympathetic estimate, the life of a remarkable alchemist shall be related in fuller detail—that of Bernard of Trèves. The materials used are to be found in Mackay's *Extraordinary Popular Delusions*.* Mackay extracted them chiefly from an autobiography, and sets them in the light most favourable to his own purpose, that of illustrating the evil results of over-credulity and superstition. Our standpoint is different—but the facts are common property.

* Vol. i, pp. 119 ff.

Bernard was the son of a wealthy man—a fact, as we shall see, of central importance. He was born at Trèves, or Padua, in 1406, a time when the search for the Philosopher's Stone was in full swing; and at the early age of fourteen he came under the spell. He had read, in the original, certain Arabian treatises on the art, and they had fired his youthful imagination. From among these authors, Rhazes more especially secured his adherence and confidence. He was certain that he had gained from him the grand secret, and that guided by his directions he would be able to augment gold a hundredfold. He at once proceeded with intense ardour to put his conclusions to the test, setting up a laboratory, and conducting endless experiments. He worked hard for four years, and, during that time, spent no less than 800 crowns on his researches. All in vain—the secret eluded him.

He was not at all discouraged. He merely concluded that the directions given by Rhazes were incomplete or imperfect, and he turned to the master of Arabian alchemists, Geber. With this new guide, he toiled for two years more, and called in the aid of various brother alchemists who were only too delighted to join a man so wealthy. Among them they spent 2000 crowns, with no result. His faith in Geber, however, was not disturbed. He concluded that his own equipment was not equal to the task of interpreting his authority, and he therefore launched out on a wider range of study.

About this time he chanced upon a student as enthusiastic as himself—a monk of the Franciscan Order—and struck up with him a friendship of the

closest kind. The pair explored together the teachings of certain obscure authors, who maintained that highly rectified spirits of wine constituted the Alkahest, or Universal Solvent—a substance which would greatly facilitate the making of the Stone. This, therefore, now became the object of their labours. They rectified alcohol till it burst the containing vessels. Three years were spent in the fruitless enterprise—300 more crowns were expended. Something was wrong. Had they mistaken the material required? They would try others, not shrinking from the filthiest. For twelve long years the experiments were continued—larger and larger sums of money were expended. So earnest was Bernard that, as he tells us, he prayed to God night and morning that success might be his. And yet all was in vain. The quest was never won.

His friend, the monk, had died. His place was taken by a magistrate of the city, a man no less enthusiastic, who was firmly persuaded that the transmuting Stone could be found in sea-salt. Bernard resolved to put the notion to the test, transported his laboratory to the shores of the Baltic, and for more than a year sublimated, crystallised, calcined sea-salt —and even drank it for the sake of other experiments. Still no encouragement.

He was now nearly fifty. Life was hasting on, and the goal seemed as far off as ever. What was to be done? Might it not be that adepts in other lands possessed the secret and would impart it? He determined to try his fortune, and set out on his travels, journeying in Italy, Germany, France, and Spain—everywhere searching out alchemists and making trial

of the suggestions he obtained. His goodness of heart is proved by his constant readiness to relieve his poorer fellow-students. In France he settled down for five years. While in that country, he heard that the confessor to Frederick III., Master Henry, had discovered the Stone. So off to Vienna he went, taking along with him five dependent alchemists. At last his perseverance would be rewarded. Not so. Master Henry honestly confessed that, though he had been toiling all his life, the secret had eluded him; but at the same time stoutly declared that he would keep up the search, if necessary till he died. Here was a man after Bernard's own heart. It was natural that the two should swear eternal friendship. Then came a curious episode.

Bernard gave a grand banquet to his newly found partner and the alchemists of the district. Those present, stimulated by the promise of Master Henry that he would increase fivefold the gold subscribed, clubbed together and collected forty-two marks. The metal was put into the crucible together with other chemicals and rubbish, and the grand experiment was made. Three days the furnace decocted the mixture, but no transmuting could be discovered. Ah, well, the temperature had been too high or too low, some ingredient was missing, some necessary process had been omitted. Further trials must in due course be made. The curious part, however, of this particular result was, that when the amount of gold in the crucible was examined, it had decreased to sixteen marks!

The fiasco proved too much even for Bernard's long-suffering spirit. He abjured further efforts to

discover the Stone; the case was really hopeless. He kept his vow valiantly—for two months! The fascination of the quest was too strong; the chance of retrieving his fortunes too insistently alluring. So off again he started on his journeys of exploration, taking this time quite a different route, visiting Cyprus, Greece, Constantinople, and extending his tour into Egypt, Palestine, and Persia—a wide enough range, and worthy of success if success had been attainable! Returning from the East, he revisited France, and crossed over to England. Four more years gone, and still unvarying failure.

He was now well over sixty; his fortune had well-nigh melted away. He wandered back to his home at Trèves, only to find that his family scorned him and deemed him a madman. Disconsolate, poor, and friendless, he sought refuge in the island of Rhodes, living there in retirement, and prosecuting his studies as far as his circumstances allowed. It was not long before he gained another opening for more strenuous operations. Another monk came on the scene, as keen as was the first, and joined him in his studies. The new partnership had hardly lasted a year when Bernard induced a merchant in the island to lend him 8000 florins; and for three more years he struggled on in enjoyment of the wealth he thus secured. Such an ending undoubtedly has a dramatic fitness, but was clearly invented to save the prestige of the craft. Human life does not always fulfil the dramatic proprieties. Perhaps, however, we ought not to moralise thus pessimistically. For Bernard himself relates that at the close he attained one great secret—that of contentment. We recall the charming essay of

Addison, quoted when the Rosicrucians were under our consideration. Was it from Bernard that Addison borrowed his climax ?

It is easy and tempting to indulge, with Mackay, in reflections on a wasted life. Deeper reflection should restrain them. Compare the story of another and a later Bernard—Bernard Palissy, the French potter. The chance sight of an enamelled cup led him to resolve that he would discover how to make enamels. He gave up all other pursuits, devoted himself for sixteen years to tireless experimenting, exhausted his resources, had not money to buy fuel, burnt the furniture and the flooring of his house. His neighbours, even his wife, mocked him. His children cried to him for food. Still he grimly persevered. Moralists, like Smiles, hold him up as a shining example of what perseverance may accomplish. Yet what is the difference between him and Bernard of Trèves ? Only this, that the one succeeded and the other failed. If it be urged that the quest of one was within the range of the practical, the other merely visionary, the answer is simple. Bernard was as convinced of the possibility of discovering the Stone as Palissy was of making enamel. Let us be fair to the alchemists.

PART IV

ALCHEMY AND SCIENCE

CHAPTER I

DIFFICULTIES OF INTERPRETATION

HAVING now accorded due recognition to the follies and impostures which loom so large in the development of the Hermetic art, let us turn to what should be the more congenial task of recording what elements of solid science it embodies, and what discoveries it made which have contributed to the founding of modern chemistry. Before entering, however, on this concluding division of our subject, it will be well to recognise the difficulties which arise from the obscurity of many alchemist authors, and from the intentional or the inevitable looseness of much of their terminology.

OBSCURITIES.

Many of the quotations given in the preceding chapters will have rendered it abundantly manifest that clearness of statement was not held to be a virtue in expositions of the Hermetic art. Adepts too frequently revelled in the use of allegories, symbols, magical formulas, and meaningless vapourings. Too frequently their definite intention was to be unintelligible. Terms were violently wrenched from their natural meanings; strange terms were invented to

entangle those who strove to extract directions for undertaking experiments. The real cause of these perversities is not to be mistaken. The writers themselves seldom had any clear ideas, and disguised the fact by shrouding their vagueness in an assumption of the pose and the language of a pseudo-mysticism. Moreover, and chiefly, as regards the great and central object of their quest, the Philosopher's Stone, they had nothing to tell—they never possessed it; it did not exist. Their position was truly a difficult one! How did they meet it? It was not to be expected that they would avow their ignorance and their failure. And so they invented all manner of high-sounding excuses for their reticence. Sometimes they dwelt on the danger of making known the great secret, alleging that if it became common property society would go to pieces, for all would make gold *ad libitum*. Sometimes they emphasised the sacredness of the secret, and refused to profane it by revealing it to the ignorant and vulgar. Or taking still higher ground, they declared that it passed human intelligence, and that God alone could unveil it, and then only to the elect. We must not unreservedly attribute to sheer deception these singular subterfuges. For the honest alchemists were really convinced that, even though they themselves had failed, others had succeeded. They believed in transmutation and in the existence of the Stone. Their thinking was confused and their motives were mixed. In short, their circumstances were strangely puzzling, and they themselves were human.

Examples of Obscurity.

Intentional obscurity was carried to extremes which are both amazing and amusing. Rhazes thus begins a description of how to make alcohol. "Take of something unknown the quantity that you wish." Figuier tells us it is not rare to find simply "Take." In the days when such directions were set down in grave treatises, it would at any rate have been easy to pass examination in chemistry! Here is an example from Basil Valentine (fourteenth century): "Cause that which is above to be below; that which is visible to be invisible; that which is palpable to be impalpable. Again let that which is below become that which is above; let the invisible become visible, and the impalpable become palpable. Here you see the perfection of our art without any defect or diminution." This might be taken as a roundabout way of telling us to heat some water in a glass flask until it was all turned into steam, and then cooling it until the steam was condensed into water; but the sage evidently had something much more recondite in his mind. Who shall say what? And yet the same author in several places reproaches himself bitterly for having spoken too plainly in his writings, and trembles lest he has revealed too much!

At a later period there is the same avoidance of definite statement, but an infusion of more fantastic symbolism. The following passage from Ripley's *Twelve Gates of Alchemy* gives a good idea of the new style: "The work must be undertaken at sunset, when the husband, Red, and the wife, White, are united in the spirit of life to live in love and tranquillity,

in the exact proportion of water and earth. From the west advance across the shadows towards the south; alter and dissolve the husband and the wife between winter and spring; change the water into a black earth, and raise thyself across the varied colours towards the East when the full moon shows itself. After the purgation, the sun appears, white and radiant; it is summer after winter, day after night. The earth and water are transformed into air, the darkness is dispersed, light is made; the west is the beginning of practical work, and the east the beginning of the theory; the principle of destruction is comprised between the east and the west."

If we are to enter into the spirit of such directions and descriptions as these we must remember that alchemy was not a science in the modern sense of the word, but a mixture of science, philosophy, theosophy, and mysticism. It was only gradually that the more trained and balanced thinkers separated facts from fancies. Not until the sixteenth century did alchemists begin to drop the veil from their speculations and practices, and try to set down in straightforward language what they really saw and discovered. And even then the advance in this direction was slow and partial.

A highly curious example of affected precision is given by Thorpe.* "To fix quicksilver. Of several things take 2, 3, and 3, 1; 1 to 3 is 4; 3, 2 and 1. Between 4 and 3 there is 1; 3 from 4 is 1; then 1 and 1, 3 and 4; 1 from 3 is 2. Between 2 and 3 there is 1, between 3 and 2 there is 1. 1, 1, 1, and 1, 2, 2, and 1, 1 and 1 to 2. Then 1 is 1. I have told

* *History of Chemistry*, vol. i, p. 39.

you all." This enigmatical enunciation reminds us of a riddle once well known to youth. Two legs was eating one leg; in came four legs; four legs ran off with one leg, and two legs threw three legs at four legs; and so on. But while there is a fair chance of guessing the riddle, the alchemist formula passes the wit of man to interpret.

Vagueness of Terminology.

Even when the formulas and receipts are based on genuine experiences and observed facts, the terminology used is often vague in the extreme. Much of it is symbolic. For instance, the names of animals are frequently used to denote mineral substances, and animal allegories to represent chemical actions. The Yellow Lion was the alchemical symbol for yellow sulphides; the Red Lion that for cinnabar; the Green Lion for salts of iron and copper; the eagle or the crow for black sulphides. Muir gives this example of a description of a process. If black sulphide of mercury is strongly heated, a red sublimate is formed which has the same composition as the black compound. If the temperature is not kept very high, there is only a little of the red sulphide produced. The operator, therefore, is directed to urge the fire, "else the black crows will go back to the nest." The expression is picturesque, but is not one that would be found in Roscoe.

Further, even in the cases where seemingly plain terms are used—such as sulphur, mercury, arsenic—it is seldom safe to assume that the alchemists mean by them what we should naturally understand. For

sometimes they intentionally twist and substitute terms, in their determination to be abstruse. Sometimes, with the best will in the world, they fail in precision because of their necessarily imperfect analysis of their materials. Sometimes they are rendered careless of finer distinctions by their theory that all substances have a common essence. For these and other reasons, accurate interpretation is always difficult and not seldom impossible. Moreover, it must be confessed that the cases where the effort to interpret is worth the while are few and far between.

We ourselves have not reached clearness in the use of all our terms.* For example, we may use the word "fire" in three senses. If we say, "Do not touch the fire," we imply, even if we have not in our minds, the idea that the fire is a *thing*, a substance. Not so long ago we should have called it "phlogiston." If we say, "The house is on fire," we mean it is in a *state*, or *condition*, of burning. If we say, "Put out the fire," we mean, "Stop the *process* of combustion" —we are thinking of *action*. From a practical standpoint, there is in this case little danger of real confusion of thought. Nevertheless it should enable us to sympathise with the alchemists when, in similar failures to be precise, they land themselves in confusion. When they spoke of "soft," "hard," "cold," "hot," they did not simply mean the states of softness, hardness, coldness, hotness, in which *things* are found, but imagined that these qualities can exist apart from the things; that is to say, that there are such *things* as softness, hardness, and the rest. And although we may not even yet have cleared ourselves of this error,

* Both Muir and Thorpe use this illustration.

at any rate when we are speaking with philosophical or scientific accuracy, we know we are using "abstract" terms. Hence we frequently find it hard to seize what the alchemists had in their minds. For instance, a famous axiom, attributed to Hermes, runs thus: "If you do not take away from bodies their corporeal state, and if you do not transform them into things not corporeal, you will not get what you want." The idea is, as explained in a previous chapter, that the metals must be stripped, or robbed, of the qualities which make them "metals" by means of substances which have not those qualities. We now express ideas of this kind by saying that substances are changed in their qualities when submitted to various physical or chemical processes. We never think of a "metal-quality" as something separate from a metal, and capable of being taken away from it like colour out of a cloth.

Straightforward Receipts.

It is only fair to note that all the receipts of the alchemists are not of a cryptic character. When the Philosopher's Stone is the subject, obscurity could not be avoided; for the substance sought or described did not exist. But when ordinary chemical actions, or the making of alloys, are dealt with, the directions are frequently straightforward enough, and the chief difficulties are the meanings to be attached to the terms. In the following chapters, various examples will be given of quite intelligible receipts and directions. A good average specimen of the earlier period is this, taken from the Book of Democritus (Arabian):—

"An Elixir which transforms silver into gold.—One pound of mercury; two pound of Persian copperas. Break up the copperas well, and throw it on the mercury; add of dulcified salt thirteen pints; stir them in a basin until all is well incorporated. Put into a new boiler and adjust the retort; heat it below until you hear the noise of the crackling salt. Take away the fire. When the vessel is cooled, take it and open it. The product which has mounted from the boiler into the receiving vessel gather and knead with juice of the round aristolochus, coloquint (lit. serpent vine) and white hellebore. Put in a glass phial. Plaster the opening and the bottom of this with mud mixed with horsehair, and leave until quite dry; then bring a lump of cow-dung; place the phial in the middle, light the fire, and let it remain there for a night. The substance will harden and become like stone. Throw it into a boiler, and pour over it acid vinegar; add flaky alum and whitened sulphur, of each a dram. Boil it until the product becomes soft like mastic. Project of this Elixir a dram on a pound of gold, and you will see appear a brilliant gold which will not lose its lustre. This has been tried, and is true." Sufficiently complicated! and yet free from mysticism or fanciful allegory.

A little further on in the same work there is a receipt for making an Elixir of Eggs which is still more complicated. It prescribes no less than twelve different operations before the final product is obtained —some of them taking days to complete, and one of them to be carried out "in the shade, not in sunlight." But even in this lengthy experiment there is no

attempt to be obscure. Other examples will be given from time to time.

It will be noticed how easily the authors assume that when they have obtained a product which has the appearance of what they want (gold or silver), they have the real thing. Increasing skill in testing and analyses overthrew this naïve confidence. Indeed, Geber himself and his followers more than suspected the truth. We can sympathise with the errors when we remember that the stress was laid on qualities rather than on substances.

CHAPTER II

THE MATERIALS

THE most vital aim of the Hermetic art was the making of gold. It therefore busied itself with a particular kind of metallurgy, calling to its aid all the known resources of chemistry. What were the materials employed by the alchemist? What were his notions of their nature and properties? These questions present themselves, both on their own account and also as preliminary to an estimate of the amount and value of the discoveries which added to the existing stock.

MAPPÆ CLAVICULA.

The treatise *Mappæ Clavicula*, as has already been said, belongs to the twefth century in regard to its form, but to the tenth in regard to its matter. The tenth-century matter, again, carries us back to Byzantine and even Egyptian days. A glance at its contents will thus give us a good general idea of the kind of chemistry practised in the early days of the art. We find directions for making various drugs, soap, starch, sugar; for the preparation of colours, white, dark blue, and azure; for cutting and moulding glass. There are various receipts with a military

reference—a lead arrow to set on fire that which it hits; poison to poison the arrows; the making of resins, oils, and naphthas, for incendiary purposes—the most famous being the Greek Fire, of which saltpetre is the fundamental constituent. One receipt runs thus: "By mixing a pure and very strong wine with three parts of salt, and by warming it in suitable vessels, an inflammable water is obtained which consumes itself without burning the matter on which it is spread." This is alcohol. While the discovery of fermentic liquors is of extremely ancient date, we here have a determinate, scientific way of dealing with it. The property of burning on the surface of a body without setting it on fire has arrested the attention of these observers.

A few of the receipts for making and for augmenting gold are given in other contexts.* The chief substances mentioned in them will be dealt with directly. There are also a large number of receipts for writing in letters of gold, or silver, on papyrus, stone, or metal. Here is one for making powdered gold. "Minium, sand, gold filings, and alum. Beat together and heat with vinegar in a copper vessel." This, though brief, proves a very considerable skill in the manipulation of the materials named. How many experiments continued through how many years had gone to the rendering of it possible! In the third part of the work are articles treating of the working of copper, iron, lead, and tin; of the colouring of glass, the making of pearls. In the fourth part come a miscellaneous set of formulas, including those mentioned at the beginning of this section. Of

* See p. 81.

special note is the hydrostatic balance for analysing alloys of gold and silver—the problem which Hiero solved. There are directions for soldering metals by methods divided into four classes. Even architecture has a place!

It is impossible, owing to the excessively mixed character of the contents, to assign dates to the discovery of the compounds named in this singular manual; we may be sure that not a few of them were due to the labours of adepts. Taking a broad view, however, it is safe to say that the great bulk of the materials used and the technical processes adopted, were transmitted from the laboratories of Egypt. Their very variety proves that they belong to a period when the learned had not concentrated metallurgical and chemical activities so exclusively on the one great quest.

Gold.

Let us consider some of the chief materials individually, keeping to the alchemist's point of view. And first of gold. Why was it that this particular metal came to occupy the place it did in the Hermetic art, and to be chosen as the perfect form which all the rest were striving to attain?

Well, was there ever a time when gold did not have a distinctive honour and repute? At the beginning of the Book of Genesis, when Paradise is being described, we read of a certain country, "the gold of that land is good." Its brilliance and beauty fascinate. It was probably the first metal to be discovered. It has remarkable qualities; it is

malleable to an exceptional degree, ductile, resistant to the effects of tarnishing agents. It could be fashioned easily into ornaments, and employed for gilding and inlaying. Above all, it was, from an unknown antiquity, concentrated wealth—it could be moulded, or coined, into money.

The alchemists, then, simply took its pre-eminence for granted. They had a keen desire to increase their store of it. And when they found that there were certain processes which seemed to promise a gratification of their desire, they set to work to learn and practise them. On the theoretical side, however, they developed the characteristic doctrine of its "fixity"—its pre-eminent power of defying physical and chemical actions. Judged by this standard, it was the perfect metal. And since nature, as they held, is always striving towards a goal, it must be this perfect metal into which all else was being transmuted. They would hasten the process.

Silver.

Silver occupied the second place in general esteem; and for reasons very similar to those which exalted gold, though of lessened force. It has a beautiful white colour; takes a high polish; is ductile and malleable, lending itself to the making of ornaments. Moreover, it was a form of concentrated wealth and could be coined into money. Its lower status, however, is explained by such a phrase as occurs in the chronicles of the great reign in the Bible, "silver was nothing accounted of in the days of Solomon." It was more plentiful, and therefore of less value. Still,

it was wealth, especially in countries which did not enjoy the opulence of Solomon's glory; and it thus became a subsidiary object of alchemical labours. "The moon (said Zosimus) is pure and divine when you see the sun shine on its surface." That is to say, silver attains its highest perfection in refining when the molten metal shines like the sun. Yes, but it is only the moon, after all—not "the glorious sun" that, as Shakespeare has it,

> "Plays the alchymist,
> Turning with splendour of his precious eye
> The meager cloddy earth to glittering gold."

One of the imperfections of silver, estimated by alchemist philosophy, is its comparative lack of "fixity." It does, indeed, resist the action of the atmosphere and of many chemical agents; but it readily tarnishes in the presence of sulphuretted hydrogen, and even a solution of common salt converts its surface into a chloride; it is also dissolved by nitric and sulphuric acids. In these respects it is clearly inferior to gold, which only yields to "the royal water." In alchemic language, it has progressed far in its development from the metal-seed; but it has not attained to perfection.

Electrum.

A specially important alloy which for long ranked as a separate metal, was that known as electrum. It derived its name from its similarity to amber (Lat. *electrum*, the usual term for "amber"; whence our "electricity"). Some of the oldest coins in existence

are of this alloy of gold and silver. It is probable that it was not always artificially produced; for in the extraction of silver from the minerals there would often be smelted out a percentage of gold. This natural origin is of great significance for alchemy, and explains much. The likeness of the alloy to gold and to silver tended to obscure the fact that these metals are definite substances, and tempted to the conclusion that they could be produced by suitable mixtures and operations. Electrum would be regarded as an intermediate stage in a continuous development. We can thus see how honest theory and intentional fraud could glide into one another. For a certain amount of silver could be added to gold without detriment to the fundamental nature of the nobler metal. That is to say, gold could be "multiplied." Especially would this consideration apply to processes of colouring impure silver which, alchemically viewed, was already approaching the state of complete transmutation.

As their skill in analysing and separating gold and silver increased, alchemists would be gradually led to understand the real nature of electrum, and they came to neglect it. In spite of this, however, its name still appeared in the list of alchemic signs. Jupiter being the planet associated with it *—affording a good example of the difficulties of interpreting formulas. Later, the name was applied to various brilliant alloys, particularly bronzes and brass. The ground for the transfer was evidently the analogy of colour.

* See p. 120.

Copper.

We come to the metals known as "base," regarded by the alchemists, not as of direct value, but as means to their end. The one likest to gold is copper. It possesses a fine rich colour, takes a brilliant polish, and is highly malleable and ductile. In spite of these advantages, its comparative plentifulness precluded its ranking as a "precious" metal. Nevertheless its use in alchemy was of the highest importance; there is no substance which appears more frequently in transmutation formulas. And the reason is not hard to find—not only its similarity to gold, but its frequent employment in the manufacture of alloys.

Pure copper is too soft a metal to be made into weapons and cutting instruments, though some prehistoric implements are found which are unalloyed. But in nature, copper ores often contain associated metals which give it the necessary hardness; and primitive metal-workers discovered that the nature of the copper differs much in different mines. Later, men learnt how to modify the metal by artificial mixtures. It was thus that bronze was manufactured by an admixture of tin. Once started, the art of alloying it made rapid strides and attained to a notable degree of efficiency.

See how readily all this played into the hands of the alchemists. Given all the variety of copper alloys, natural and artificial, it was evident that there were stages of increasing likeness to gold. Moreover, these stages could be made to pass into one another by insensible gradations. There was thus a

strong suggestion of a continuity of development. The qualities of the metal, particularly its colour, marked it out as a hopeful substance for experiment. It seemed as though so little were needed to effect the great change. It is therefore not surprising that copper was a favourite material in the transmuting art.

Bronze, Brass, Aurichalcum.

Among the alloys of copper, certain were given special names. Bronze is an alloy with tin, brass an alloy with zinc. (This is the distinction commonly made, though not strictly maintained.) Along with these, in olden times, was ranged aurichalcum, or golden copper—a term which appears to have included, among the Greeks, all the yellow alloys which resemble gold by their brilliance. In Pliny's day, it was made by heating together copper, cadmia (calamine), and charcoal.

As can be well imagined, the confusion in the use of these names was extreme, and renders interpretation of formulas, when exactness is sought, precarious or impossible. The alchemists thought that they were dealing with simple differences of development. We, in these days, have to know the definite quantities of fixed substances employed.

Mercury.

After what has been said about the Mercury of the Philosophers,* insistence on the alchemical importance of this metal is unnecessary. And even were evidence

* See p. 92.

lacking, we should be sure that a substance with characteristics so marked could not fail to have stimulated research and speculation. One of its earliest names was "living silver"—our "quicksilver." It was not called mercury until the Middle Ages, when it had become the Hermetic substance *par excellence*. Its liquidity, and the extreme mobility which makes it seem alive, always produced a profound impression upon those who reflected on natural phenomena; hardly less so, its corrosive and poisonous properties which led Pliny to call it *venenum rerum omnium*. The same author knew of its amalgamating powers, and of the readiness with which it dissolves gold.

It dissolves gold! Could anything be more calculated to excite an alchemist's wonder and expectation? He concentrated on this metal his most earnest study. It is hardly ever absent from his thoughts or his experiments. Ben Jonson, in his Masque, *Mercury Vindicated from the Alchymists*, presents it as a tortured victim. He makes it expostulate thus: "I am their crude and their sublimate; their precipitate and their unctions; their male and their female, sometimes their hermaphrodite—what they list they style me. . . . See, they begin to muster again, and draw their forces out against me. The genius of the place defend me!"

If we go back to the early days of the art, we find Zosimus giving vent to his emotions in the following rhapsody: "Concerning the divine water (that is, Mercury). Here is the grand mystery, the thing most chiefly sought. It is everything. Two natures, one single essence; for one of them draws on and

controls the other. It is liquid silver; it is of both sexes; and is always in movement. It is the divine water of which none knows. Its nature is difficult to understand; for it is neither a metal, nor water, nor a (metallic) substance. It cannot be tamed, for it is all in all. It has life and it breathes. He who understands this mystery possesses both gold and silver. . . . Its power is hidden; it resides in the Eroytle." * Zosimus fittingly appends to his description magic figures and formulas. There are also three concentric circles with the mystic axioms: "The All is one; by it is all, and in it is all. The Serpent is one; it has the two emblems and the poison." Below this again are the alchemic signs for the four metals, lead, mercury, silver and gold, surmounted by that of the world and the cosmic egg. We must remember that more was in view than the ordinary metal—it was the Philosopher's Mercury, the inner essence of all things. Some said it could be obtained by distillations; others said it was out of human reach. It was said to be liquid, yet not wetting things; volatile, yet negativing the volatility of other substances. It was at once a substance and not a substance, but an intangible Essence; a bodily spirit and a spiritual body. If we stumble at these contradictions, it may do us good to read a modern description of the luminiferous ether!

Mercury and Sulphur.

With mercury was associated another substance which also had a peculiar fascination for alchemists

* A fabulous stone, the use of which (as said the alchemists) Democritus exalted for divining.

—sulphur. We have seen * how it was supposed to be a constituent of the metals, supplying the fiery element in them. They watched wonderingly as they saw mercury dissolving gold. They also wondered when they saw a stick of sulphur, when placed on red-hot iron, penetrate the metal like a spirit, and dissolve it in a stream of molten drops. They observed, too, how that by the contact of the two substances a new one was formed. A mysterious change had taken place. Evidently, they concluded, sulphur has a peculiar power over the metal and controls its form and qualities.

Some unknown alchemist, impressed by the peculiar properties of mercury and sulphur, coupled them together as components of all the metals. The mercury was supposed to supply the lustre, malleability, ductility, fusibility—in short, the metallic qualities; sulphur supplied combustibility (and colour?). This remarkable theory is mentioned by Geber, and he himself attributes it to the ancients. It was accepted up to the middle of the sixteenth century, and forms a characteristic part of alchemist doctrine. Thorpe, so far from condemning it, hails it as the first manifestation of scientific thought in this department of research.

Tin.

Tin is another metal which had its appeal for alchemists, not so much in reference to gold as to silver. The qualities that attracted them were its silvery white colour, and the brilliant lustre it has

* See p. 94.

when new or cleaned. It resists the action of air and water; and acids (save nitric) do not attack it vigorously unless with the aid of heat. It thus possessed the alchemical virtue of "fixity." Its properties are in some ways intermediate between those of lead and silver. This fact suggested its use as a starting-point in attempts to produce silver. It was regarded as a sort of lead; and, indeed, was called "white" or "silver" lead, as opposed to "black" lead. It has a peculiar cry—a curious crackling sound—when a slender bar of the metal is bent. This is due to the crushing together of its crystalline particles. This "cry" was the first quality that adepts "stripped off." *

Lead.

The bluish-white colour of lead, and its bright colour when newly cut or melted, led to its being closely connected with silver. And the notion would be confirmed by the fact that silver is often extracted from lead by refining processes known to ancient metallurgists. A common alloy among the Romans was a mixture of lead and tin which they called *argentarium*.

According to the Greek alchemists, lead was the generator of other metals. More especially they held that it served to produce the three kindred metals, copper, tin, and iron, by the mediation of one of its derivatives, the protean magnesia. It is curious to bring together this idea and the modern discovery

* See p. 98.

that lead is one of the products formed by the breaking down of radium. Of this, more anon.

Iron and Magnesia.

These two substances, though of prime importance, do not call for special description. The latter came to be almost a synonym for the Stone.

Other Materials.

The alchemists were in quest of a metal. Naturally they began with the metals in their efforts to transmute. The Cosmopolite says: "If you want to make a metal, take a metal; for a dog is never engendered but by a dog." But the continued failure of their experiments led them to try other substances. In the later stages of the art, those selected are sometimes as startling as they are disgusting.

Arsenic was one of the first less usual metals to be tried, and for long inspired great confidence. Its power of bleaching copper suggested transmutation into silver. Mercury and tin failed. Antimony came into fashion only to be discarded in its turn. Then Roger Bacon ruled out all the metals on the score that they were too poor to generate gold.

If not metals, what next? The salts were given a chance, especially sea-salt. We remember how Bernard of Trèves moved his laboratory to the Baltic to test the possibilities of sea-salt.* Saltpetre also was in great requisition—then vitriol. Still the great

* See p. 163.

secret was unsolved. The whole realm of minerals was found wanting.

If not minerals, what next? Well, there was the vegetable world. And had not some of the Greek alchemists suggested that here there might be hope? Let their formulas be extended. Accordingly juices of the celandine and of the primrose were tried, in reliance on their colour—rhubarb, honesty, and many other plants. Still no success.

Ah! But is not the animal world higher than the vegetable; and its materials, are they not richer? Let those be tried, said the adepts. So to work they went on organic matters derived from animals—bones, flesh, blood, saliva, hair, and other materials not always fit to be mentioned. The ruling idea was that in such substances there resided the principle of life, which can transmute food into tissues. Very singular was one of the arguments used for holding that this principle could even produce metals. There was testimony, they said, that children had grown gold teeth! And with all this, unceasing failure.

One last venture. Was not the Philosopher's Stone in reality the soul of the world—*spiritus mundi?* What in nature was most akin to this? The air. If so, those substances which are most exposed to the action of the air would be likely to absorb most of the spiritual essence—such as, freshly fallen rain, snow, and dew. It is hard to believe that in 1665 an adept submitted to the Royal Society "observations on the dew of the month of May." Others took a yet wider flight. Meteoric matter, that of "falling stars," would absorb the spirit in traversing the atmosphere. Others tried to side-track the problem.

They reflected that crabs, lizards, and serpents, if deprived of food, could live for a long time on air. Must this not involve a considerable condensation of the spirit? So these wretched creatures were made to fast, and were then distilled! To what strange lengths even clever men can go when they set out on a wrong track, if there be a touch of the occult and the mystic!

Solvuntur tabulæ risu. Well may Surley, in Ben Jonson's *Alchymist*, exclaim disdainfully—

> "Your broths, your menstrues, and materials,
> Of lye and egg-shells, women's terms, man's blood,
> Hair o' the head, burnt clout, chalk, merds, and clay,
> Powder of bones, scalings of iron, glass,
> And moulds of other strange ingredients,
> Would burst a man to name."

And yet, after all, as we shall see, underneath all these eccentricities and follies, there was being built up a solid basis on which the science of the future could be reared.

CHAPTER III

THE LABORATORIES

A TYPICAL mediæval laboratory was a place for work. That is certain. But it was much more than this. It had an air of mystery; its furniture was decked with signs and symbols that appealed to the imagination and the emotions. Not seldom it was also a place for religious exercises. A prominent object might be an altar from which incense was rising; before it the sage would offer prayers for the success of his experiments. That is to say, the labour was not undertaken in the hard clear light of science, but in an atmosphere of mystery and devotional fervour. We have in this fact a manifestation of what was at once the strength and the weakness of the Hermetic art.

Intrusion of Feeling.

This atmosphere of emotion was present from the first. Even in the *Mappæ Clavicula* there occurs a direction like this: "The Making of Gold.—Prayer you are to recite during the operation, or the fusion that follows, in order that the gold may be formed." The prayer here alluded to is of the incantation class, and is in conformity with the ancient practice of the

Egyptians and the Greek alchemists. At the start, it is a matter of the magic which was always associated with industrial and medical operations. In mediæval times, the magic yielded place to a dependence on God.

Among some fragments of Arabian treatises occurs a passage which is highly characteristic. After discussing certain curious questions, the author suggests a prayer which will keep the adept in a proper frame of mind: "Our Father which art in heaven, give intelligence to the eyes of Thy servant, that he may participate in Thy pure light which dwells in heaven. (Thus far the petitions are plainly Christian.) Thou holdest the keys of the world; Thou art the beginning and the end; Thou dwellest in the midst of the fire on earth, Thou alone canst inflame water and the sea, make fish to dwell on land, recall the dead from the dark abyss and open Tartarus. Thy person is fire, Thine eyes stars. . . . The air is the brightening of Thy flame. (These are invocations of the form common in ancient Egypt and are connected with magic.) Abandon me not, O God, . . . but give me wisdom of Thy right hand and the aid of Thy people. O God, deign to enter quickly my heart. Penetrate my spirit and fill me with the flame of true science; let it dwell in my being. Chase from my soul evil and envy. . . . It is Thou Who givest the heart to produce what is good and the tongue to divulge hidden mysteries." Such is the extraordinary mingling of Christian prayers and invocations borrowed from ancient Egypt, of the kind common among the gnostics. It is followed by a bizarre account of how the author fought against personified envy, which he overcame with a hatchet.

But this play of emotion did not render the alchemists idle dreamers. Their laboratories were scenes of genuine hard work. Muir quotes, on this point, a passage from Paracelsus: "They are not given to idleness, nor go in a proud habit, or plush, or velvet garments, often showing their rings on their fingers, or wearing swords at their sides with silver hilts, or fine and gay gloves on their hands; but diligently follow their labours, sweating whole days and nights at their furnaces. They do not spend their time abroad for recreation, but take delight in their laboratories. They put their fingers among coals, into clay and filth, not into gold and rings. They are sooty and black, like smiths and miners, and do not pride themselves upon clean and beautiful dress."

Apparatus.

The apparatus of alchemy was primarily devised of course for practical uses; but, like all else connected with the Hermetic art, was invested with an atmosphere of the mystic and occult. Mammon, in Ben Jonson's *Alchymist*, declares that the fable of Medea's charms had reference to—

> "The manner of our work; the bulls, our furnace,
> Still breathing fire; our argent-vive, the dragon:
> The dragon's teeth, mercury sublimate,
> That keeps the whiteness, hardness and the biting;
> And they are gathered into Jason's helm,
> The alembic, and then sow'd in Mars his field,
> And thence sublimed so often, till they're fix'd."

In some of the Arabian treatises, and in others of the thirteenth century, there are simple outline

pictures of many kinds of vessels.* We there find aludels, or pear-shaped pots open at both ends, and made to fit into each other; alembics for distilling, retorts and stills, for heating and sublimating; flasks, for burying in beds of hot sand or cinders; furnaces great and small; athanors, or furnaces specially constructed to maintain a certain degree of heat; cucurbits, or gourd-like alembics; pellicans, or vessels with arms; and many a quaint device beside. A special kind of bath was that named *Balneum Mariæ*. In the midst of a series of processes denoted by letters of the alphabet Subtle reports to Mammon—

> "F is come over the helm too,
> I thank my Maker, in S. Mary's bath,
> And shows *lac virginis*. Blessed be heaven!"

It is mentioned in the older treatises, and connected with Mary the Jewess who is supposed to have invented it. Nothing definite is known of her. A writer of the seventh century affirms that she was initiated into the sacred art in the temple of Memphis. Another legend makes her the sister of Moses. This particular instance is typical of the way in which alchemists mingled fact, legend, and fancy in their effort to preserve the sense of mystery, even in regard to their familiar utensils. It also incidentally illustrates the constant backward look to Egypt.

Further detail under this head is not necessary. But it is well to note that many of the vessels still retain their places, even as regards specific forms, in our modern laboratories.

* Berthelot, in his *La Chimie au Moyen âge*, vol. i. ch. vi., reproduces many of these, and is generally able to determine the use to which they were put.

AN ALCHEMIST'S LABORATORY.

[*P.* 196.

Processes—Ben Jonson's List.

Geber gives a list of the principal processes in vogue in his time. He mentions sublimation, volatilisation, distillation by evaporation or by simple filtration, calcination, solution, coagulation, which includes crystallisation and fixation, coupellation, softening of hard bodies, and so forth. Most of these, save for technical modifications, date back to Greeks, and, behind them again, to the Egyptians. They are, indeed, simply adaptations of quite familiar processes; but they were given new settings and specialised purpose by the alchemist philosophy, as means for hastening the advance of various substances towards perfection. This point is well brought out by Ben Jonson. Subtle addresses his servant:

Sub. Sirrah, my varlet, stand you forth and speak to him
Like a philosopher: answer in the language.
Name the vexations, and the martyrisations
Of metals in the work.
Face. Sir, putrefaction,
Solution, ablution, sublimation,
Cohobation, calcination, ceration, and
Fixation.
Sub. (*to* Ananias). This is heathen Greek to you, now!—
(*to* Face). And when comes vivification?
Face. After mortification.
Sub. What's cohobation?
Face. 'Tis the pouring on
Your aqua regis, and then drawing him off,
To the trine circle of the seven spheres.
Sub. What's the proper passion of metals?
Face. Malleation.
Sub. What's your *ultimum supplicium auri?*
Face. Antimonium.
Sub. (*to* Ananias). This is heathen Greek to you.
(*to* Face). And what's your mercury?
Face. A very fugitive, he will be gone, sir.

Sub. How know you him?
Face. By his viscosity,
His oleosity, and his suscitability.
Sub. How do you sublime him?
Face. With the calce of egg-shells,
White marble, talc.
Sub. Your magisterium, now,
What's that?
Face. Shifting, sir, your elements,
Dry into cold, cold into moist, moist into hot,
Hot into dry.
Sub. (*to* ANANIAS). This is heathen Greek to you still!
(*to* FACE). Your *lapis philosophicus?*
Face. 'Tis a stone
And not a stone; a spirit, a soul, and a body:
Which if you do dissolve, it is dissolved;
If you coagulate, it is coagulated;
If you make it to fly, it flieth.

This passage brings out many points of interest, especially the idea that qualities are separate things. But its main drift seems to be founded on George Ripley's *Twelve Gates*, or twelve successive processes which open out on the Paradise of the Philosopher's Stone. Indeed, Jonson mentions Ripley a little earlier in the scene. Let us examine a few of these processes from the alchemist's standpoint.

PROCESSES IN DETAIL.

Calcination was employed by Geber for rendering metals more fixed; that is to say, for robbing them of the qualities which made them unlike gold or silver. Tin, for example, was thus robbed of its "cry," lead of its fusibility. The result of the process was, in reality, generally some form of oxidation.

Sublimation, so far as the process is concerned, meant much the same as with ourselves. A substance

is sublimated when it is distilled or volatilised and then allowed to crystallise or condense in solid form. It is therefore a purifying process, and it is on this result that the alchemist lays the stress in relation to his doctrine of qualities as separable things. The grosser of these had to be stripped away. When the substance, on cooling, takes again a "corporeal" form, it was supposed to have become more "spiritual," and so to have advanced a stage on the way to perfection. It was by a series of such spiritualisings that the quintessence (the fifth, or last and highest, power) of a substance was obtained. Here, also, comes in the idea of Fixation. The alchemist supposes that by a succession of volatilisings and reformings, a metal becomes more fixed. We now know he was in error; for an element remains unchanged no matter how many times it is thus treated. But in view of his theory of a continuous development, we can understand and excuse him.

Putrefaction brings on the scene another range of ideas—those of a metal-seed and of organic growth. Correlative with it are the processes known as Mortification and Resurrection. As we have seen, this animistic aspect of chemical actions was the basis for many fantastic allegories, several examples of which have been given in other contexts—the killing and the death of the metal-seed if there is to be new growth. The reference is really to the formation of new compounds not recognised as such. Another trace of animistic doctrine is found in a process mentioned by Ripley, Cibation—the process of feeding the crucible with fresh material. We still speak of "feeding" a fire, as though it were a living thing.

With us this strong expression has worn down to be a mere figure of speech; but it was not always so.

Geber's "softening" process — Ben Jonson's "dulcifying"—was one which causes a substance to become soft and flow like wax. It would often involve special mixtures or infusions, as well as the application of the right degree of heat. Ripley calls it Fermentation. But this term had usually a more fundamental meaning. It implied that gold and silver, being alloys, could be reproduced and multiplied by developing in their mixtures a change analogous to fermentation in the modern sense of the term. This is a far-reaching idea of which we have not yet heard the last.

Cohobation is a repeated distilling in which the liquor is poured back upon the matter remaining in the vessel, the object being to increase the amount of the principles or virtues desired in the final product. The word is probably of Arabic origin; and the operation itself is still at times employed. Ceration implies the wrapping of a substance in wax; but the alchemists included under it any preparation of a substance, especially a metal, for fusion or liquefaction. Solution and Ablution do not need explanation, save in so far as to note the mystical character assigned to these and other similarly simple operations in the Hermetic art.

Fixation has already been explained.* Another term with an equally specialised meaning is Projection. Originally this signified the throwing of any kind of material into the crucible. It came to be applied, however, to the one supreme "throwing on"—that of the "powder of projection," or the Philosopher's

* See p. 181,

Stone. The result was to be the transmutation or multiplication that was to reward the adept for all his toil. The idea of a powder of transmutation seems to date back to the days of ancient Egyptian metallurgy. For in an early document it finds mention thus: "We must know in what places of the Thebaid the mysterious powder is prepared." There follows a list of the Egyptian cities and districts in which it might be sought, evidencing the existence of some pre-alchemist tradition.

The adepts of the sixteenth century were greatly concerned with the bringing together of the male and female seeds by which gold was to be generated. For accomplishing this purpose the seed-materials were enclosed in an oval of paste or mud, and hermetically sealed. Thus was formed what was called the Philosopher's Egg,* or "the house of the pullet of the wise," or Athanor. Salmon tells us how this operation is to be carried out. "Here is the way in which philosophers make sure that the thing is accomplished. The Philosopher's Mercury being joined and amalgamated with gold of great purity, and in leaves or filings (gold being the male, mercury the female), is put into the Philosopher's Egg. This Egg is placed in a dish full of charcoal which is put on the fire, and then the mercury, by the heat of its internal sulphur excited by the fire kindled by the operator from without, and fed continually in the degree and proportion necessary—this mercury, I say, dissolves the gold without violence, and reduces it to atoms." At the end of six months, a black powder is obtained which Salmon calls "the crow's head," or Saturn, or

* The mystical doctrine of the Egg was discussed before, see p. 121.

Cimmerian darkness. If the action of the heat is prolonged, the substance becomes white. This is the white colouring substance, or the Little Philosopher's Stone, and is able to convert ordinary metals into silver and to produce pearls. Lastly, if the fire is increased, the substance melts and changes into a red powder. It is the veritable Philosopher's Stone! Projected on a common metal, it immediately changes it into gold.

We find, then, that the alchemists devised a very considerable set of experiments and operations, which, though devoted to an unattainable end, went a long way towards bringing into existence the apparatus of the modern laboratory.

CHAPTER IV

ADVANCES AND DISCOVERIES

ALCHEMY failed in its quest—its grand secret was never solved. But we have already seen good reasons for rejecting the superficial judgment which condemns the art as worthless. Bacon was not wont to be mild in his criticisms, and fully realised the failings of the alchemists' aims and methods; but he was judicial, and substantially mitigated the severity of his sentence. "The derivations and prosecutions (he writes) to these ends, both in the theories and in the practices, are full of error and vanity; which the great professors themselves have sought to veil over and conceal by enigmatical writings, and referring themselves to auricular traditions, and such other devices to save the credit of impostures. And yet surely to alchemy this right is due, that it may be compared to the husbandman whereof Æsop makes the fable, that when he died told his sons that he had left unto them gold buried underground in his vineyard; and they digged all over the ground, and gold they found none, but by reason of their stirring and digging the mould about the roots of their vines, they had a great vintage the year following: so assuredly the search and stir to make gold hath brought to light a great number of

good and fruitful inventions and experiments as well for the disclosing of nature as for the use of man's life." * Let us now review the more important of these "good and fruitful inventions and experiments."

The Combining of Theory and Practice.

The first great merit of alchemy was that it brought together philosophical speculation and the practical arts. The Egyptian metallurgists and chemists, even those of them who were priests, were neither scientists nor philosophers. No doubt there would be among them a certain spirit of inquiry concerning the nature of the materials they employed; but they never evolved any system of speculative thought which deserves the name of a philosophy of nature. Why this should have been so is an interesting problem, the solution of which would tempt us from our track. Suffice it to note the fact. The alchemists inherited from the Egyptians little but an accumulation of technical receipts and directions.

On the contrary, the Greek thinkers who supplied the speculative ideas of alchemy were not skilled in the practical arts, nor were they, in any strict sense, natural scientists. They did not even foster a scientific spirit; for they despised all handling of materials for purposes of manufacture or experiment, leaving such tasks to slaves and ignorant workmen. And they were thus debarred from gaining any factual basis for their reasonings.

Now by a happy concurrence of circumstances, the

* *Advancement of Learning*, Bk. i.

alchemist, while interested in philosophy, had himself to become an operative, and actually handled the materials he employed. The gain was great. Theories had perforce to be submitted to the test of facts. And it was gradually realised that facts are decisive when knowledge of, or power over, nature is the object in view. A new start was made on principles not definitely recognised, but none the less revolutionary —principles rendered explicit in Bacon's *Novum Organon*. The rate of advance, however, was lamentably slow. Theory, though no longer in a solitary throne, was unduly despotic, and blinded the experimenters to the real significance of nearly all they saw. They lost themselves in many a maze forlorn when they might have been expatiating on Nature's highways. Hence it was that their scientific achievements were so scanty as compared with the lengthy period during which the art was prosecuted.

Dawn of the Scientific Spirit.

Alchemy, then, heralded the dawn of the scientific spirit in the sphere of chemistry and the kindred arts. The rigidity of the subjective attitude was relaxed. A passage from the Arabian treatise, *The Little Book of Clemency*, will illustrate this point. "Wise men do not pride themselves on the quantity of materials, but on the perfection of their operations. I urge you to act with precaution, to go to work slowly, and to follow the example of Nature in all that you desire to do when dealing with natural things." There is here manifested an incipient tendency to look without

rather than within. We must not, however, lay too much stress on the phrase "follow the example of Nature," for ancient philosophy gave to it a turn which was far from "natural" in our modern scientific sense of the term. Nevertheless, the effort towards detachment is full of promise.

A passage from *The Book of Ostanes* shows an insight into the possibilities of natural processes. "Science brings it about that things the most precious are made out of the most common. See, for example, the loveliest garments in the world are of silk; and silk comes from a worm. The finest of the things we eat is honey; and honey comes from a fly. Musk is the product of an animal, ambergris that of a fish, and the pearl that of an oyster. So with this marvellous stone; it comes from matter that in eyes of the ignorant is of the commonest." Though the object aimed at is chimerical, the reasoning is in the spirit of science, and could be supported by many modern parallels.

Yet more striking is this from *The Book of Pity*, which describes an observation founded on fact. "There was a magnetic stone which lifted a piece of iron weighing 100 drachmes. We kept it for a long time, and we tried it on another piece of iron which it was not able to lift. We thought that the weight of this piece of iron must exceed 100 drachmes, the weight which the magnetic stone before lifted. But when we came to weigh it, we found that it weighed less than 100 drachmes. The power of the stone, then, had diminished, although its own weight had remained the same as at the first." This is quite in the modern manner, particularly the weighing of the

magnetic stone itself to see if the diminution in power had decreased its substance.

This spirit of detachment went far enough, even in the Arabian period, to allow of doubts of the possibility of transmutation; and these doubts were grounded, not always on the fact of failure or the frequent occurrence of fraud, but on scientific argument. Avicenna, for instance, opposed the idea of transmutation by urging that the metals differ in their specific properties, each of them forming a definite species with real characteristics of its own. He concludes that there cannot be a shorter way of bringing the metals to their perfect state than that followed by Nature. It is plain, then, from evidence such as this, that the scientific spirit was beginning to declare itself in the early days of the art. Subsequently, it was from time to time obscured, or crushed, but it never died; and in the minds of a series of independent thinkers it steadily gained in strength and clearness, until it at last overthrew the art which had given it birth. How the development came to pass will be rendered apparent if we consider the method which is its most characteristic ally.

The Experimental Method.

Speaking broadly, alchemists framed hypotheses and strove to bring facts into harmony with them. The true scientist also frames hypotheses; but he brings them to the touchstone of the facts, and holds to them only so long as the difficulties raised are not too numerous or formidable. For the alchemist, an experiment was an attempt to realise the truth of a

foregone conclusion. For the scientist, an experiment is a question put to Nature to see if she will support his theory or throw further light upon his problem. The two methods are thus sharply opposed, and postulate two widely different outlooks. It was not until the latter had been consciously adopted that science could advance with sure and rapid strides.

Roger Bacon.

Roger Bacon (1214–1294) was one of the first to realise the importance of the distinction just drawn. His remarkable gifts enabled him to break away from the traditions which had enslaved so many great minds, explore new territory, and open out new routes. For a long time he was looked upon as an alchemist of the orthodox kind, and even branded as a sorcerer. But of late years he has come to his own, and we appreciate him at his true value. The secret of his success was this—he had learnt how to put questions to Nature. In the Arabian, Rhazes, we find this noble statement: "The secret of chemistry is rather possible than impossible. Its mysteries are only revealed by dint of hard work and tenacity. But what a triumph when man is able to raise a corner of the veil which covers nature!" Rhazes and Friar Bacon join hands. Both are hungry for facts; but the later sage had the larger outlook and the deeper power of penetration. How varied were Bacon's interests! He corrected the Julian Kalendar; analysed the properties of lenses and convex glasses; invented spectacles for the short-sighted; propounded

the theory of telescopes, if he did not make them; prepared the way for the discovery of gunpowder and of the air-pump; and, most significant of all, drew attention to the chemical *rôle* of the air in the process of combustion. Truly a splendid record when we think of the times in which he lived—a record which, though exceeding the bounds of alchemy, may fairly in its main tendency redound to the credit of that art. And how was it attained? By the definite adoption of the experimental method. The success, it is true, was achieved in spite of the shackles imposed by alchemist traditions; still, the means to the success had largely been provided by the art they were destined to destroy. And Boyle was a legitimate successor of the alchemist Friar.

Aristotle.

It was stated just above that Bacon had to force his way through a mass of traditions which blocked the way to progress. The bulk of these were supposed to depend on the authority of that pre-eminent thinker, Aristotle—"the Master of those who know." How grievously that gloriously free and original genius has suffered in the house of those who imagined themselves to be his friends! It is certain that his authority was supreme in Europe for nearly twenty centuries, and that his influence, even in the history of chemistry, can be traced down into the eighteenth century. But was the appeal to the real Aristotle? So far was this from being the case that it was more often than not to teachings quite opposed to those which he had promulgated. Dialecticians had robbed his arguments

of their living force, or twisted them to alien issues. Commentators had tortured his doctrine or buried it under mountains of uninspired disquisitions. Spurious treatises, published under his name, had misrepresented and supplemented it out of all recognition. What wonder, when the liberation came, that he was blamed and abjured!

As a matter of fact, Aristotle himself had strongly emphasised his conviction that natural science can only be advanced by increase of the knowledge of Nature. He was, of all the ancients, the one who comes nearest to the moderns in aim, spirit, and method. And it was indeed an irony of fate that made the repudiation of dogmatism seem to be a triumph over, instead of a continuance of, his work. The interest in practical chemistry which, despite all its defects and aberrations, the Hermetic art had sustained, the flickerings of the scientific spirit which it had fostered, the experiments it had suggested—these were the true Aristotelian elements in an otherwise fruitless quest.

Arabian Discoveries.

An attempt to enumerate in detail the discoveries upon which, in the course of so many centuries, the seekers for the Philosopher's Stone had more or less accidentally happed would be tedious. But an apology for alchemy would be deprived of its chief vindication were it not to record some of the more notable additions made to the store of human knowledge. It is an easy task to show that they were neither few nor unimportant.

The Alexandrian period is too nebulous and confused to allow of any trustworthy statements under this head, especially as it is also almost impossible to estimate the amount of their debt to the Egyptians. Berthelot has laboured hard in this field of inquiry; but his conclusions are too technical to allow of a general summary. We may be sure, however, that this earliest stage was not altogether barren of valuable results.

Even when we come to the Arabs, it is not easy to lay hold on any specific facts in regard to particular discoveries. For though mediæval alchemists had high admiration for their Muslim predecessors, it is by no means clear how far we may safely lean on the testimony they bear. We have to reckon with the tendency the Westerns had to look to the East for wisdom, especially that which savoured of the mystic and occult; and also with the uncertainty that hangs over the authenticity of treatises ascribed to Eastern sages. Berthelot, after an exhaustive examination of the available evidence, reaches the cautious conclusion that we may credit the Arabians with making considerable progress in medicine, dyeing, enamelling, the making of coloured glass, as well as in the metallurgy which constituted the peculiar province of alchemy, as such.

The famous Geber is said to have discovered sulphuric acid, nitric acid, and nitrate of silver—three chemicals which retain a foremost place in modern laboratories. Specially associated with his name is the liquid *aqua regia*, a mixture of nitric and hydrochloric acids which dissolves gold—so called because of its power over the " royal " metal. The resulting

solution, *aqua regalis*, he regarded as the Elixir of Life. It was administered as "potable gold." In this view he was followed by Roger Bacon, who told His Holiness Pope Nicholas IV. a story concerning its marvellous virtues. An old man, he said, found some yellow liquor (the solution is yellow) in a golden phial while ploughing one day in Sicily. Supposing it to be dew, he drank it. He was thereupon transformed into a hale, robust, and highly accomplished youth. We do not know whether the Pope tried the Elixir; or, if he did, what was the effect upon his constitution.

However these things may have been, the record is given in certain Latin manuscripts of the thirteenth century, and the discoveries must therefore have preceded this period. Of Geber himself we may safely aver that he was the first to give precise descriptions of the metals mercury, silver, lead, copper and gold; and that he first noted the uses of corrosive sublimate, red precipitate, and flowers and milk of sulphur. Rhazes prepared brandy and employed alcohol as a solvent in several pharmaceutical preparations. He examined the properties of orpiment, realgar ("powder of the mine"), borax, and various compounds of sulphur with iron and copper. The school as a whole made valuable advances in medicine, and manifested a fine spirit of scientific research in many other directions. There can be no doubt that our debt to it, though not capable of detailed determination, is very considerable.

Mediæval Discoveries.

It is not until the time of Roger Bacon that the work of individual adepts stands out with sufficient

prominence to render possible the dating of specific discoveries, and the honouring of the discoverers. As we saw in the chapter on "Materials," substance after substance makes its appearance in the early mediæval period of alchemy, but without mention of particulars. The store simply accumulates. None the less there was steady, if slow, advance—similar, we may fairly assume, to that of the days when historical evidence is more abundant.

Roger Bacon we have considered above—his preparing the way for the discovery of gunpowder, and his suggestions about the part played by the air in the process of combination. Another famous alchemist, Albertus Magnus, was even more successful in respect of chemical discoveries. Not only was he acquainted with the purification of metals by means of lead, with various chemical uses of alum, and with caustic alkali, but he determined the composition of cinnabar (an ore of mercury) by forming it wholly from the metal and sulphur, described accurately the preparation of acetates of lead and copper, noted the effects of heat on sulphur, and utilised the action of aqua fortis in separating alloys of gold and silver. No mean achievement this, when we take account of the times and the opportunities! Moreover, he was the first to speak of the "affinities" of substances—an idea of fundamental importance in modern chemistry. His pupil, Aquinas, employed the term "amalgam," connected probably with the Greek *malagma*, softness. The amalgams of which he treated were those of mercury with another metal or combination of metals. Medallists came to use the word of any kind of soft alloy; then the idea of "softness" fell away, leaving

merely that of intimate mixture. This development admirably illustrates the way in which alchemist terminology and practice may be quietly absorbed with but little recognition of the source.

Raymond Lully was another genius who took the whole field of knowledge for his province. In the sphere of chemistry, he prepared carbonate of potash by means of tartar and wood-ash, and discovered several essential oils. He was especially interested in "spirit of wine," the art of distilling which would seem to have then been but recently learnt. He bestowed on it the honourable name of *aqua vitæ ardens*, and in his enthusiasm declared it to be the very Elixir of Life.

To Basil Valentine were assigned many triumphs. But it has been shown that his name was assumed by a certain Johann Thölde, an author of the seventeenth century, and it is therefore no easy matter to say what really belongs to him or to a later date. But in any case the discoveries were made by alchemists; and, bearing in mind the need for critical caution, let us group them under his name. He prepared metals by what are called "wet" methods. For example, he transformed pyrites into sulphate of copper through the action of humid air, and then plunged a plate of iron into a solution of the sulphate, thus obtaining pure copper. He prepared sulphide of potash, fulminating gold, and sulphuric ether. He wrote a complete treatise on "salts," with particular treatment of "spirits of salt" (hydrochloric acid)—an achievement of great significance. He obtained the acid (as now) from sea-salt or oil of vitriol. He devoted much attention to antimony, and examined

many of its compounds, some of which have been rediscovered recently and thought to be new acquisitions. He experimented with the air of mines, and determined its fitness for respiration. Most striking of all were his conclusions about what he called "spirit of mercury." This, he said, is nothing else than an air flying here and there without wings, which, after it has been chased by Vulcan (fire) from its home, returns to the chaos, and then expands to pass into the air from which it had been derived. What is this but the gas liberated by heating mercury oxide? Höfer, in his *History of Chemistry*, holds that this is an early discovery of oxygen—an anticipation of Priestley and Lavoisier.

The instances above given are but a selection from a much larger number. Granting that most of them were stumbled on by accident, and were by-products (so to speak) of the art, they nevertheless serve to prove that alchemy was "the chemistry of the Middle Ages." Let the object of the quest have been as chimerical as you will, the guiding theories mistaken or fantastic, the methods unsystematic, still the discoveries were made and provided a basis for the rise of the modern science.

Medicine.

The main object of the alchemist's quest was the Philosopher's Stone for the winning of gold. But we have seen that from the first there was united with this the idea of an Elixir of Life. That is to say, there was always a close alliance between the art of transmuting and the art of healing. Adepts were frequently, especially in the earliest and in the latest

periods, professional physicians. The result was two-fold. Chemistry which had been despised by philosophers, became a subject of serious study by men of learning and distinction. Medicine was brought within the range of physical experiment. It is to the Hermetic art that we must credit these two enormous gains, since, but for the hope of transmuting, the hand of tradition would have lain yet more heavily on these nascent sciences.

The alliance between alchemy and medicine has been adequately dealt with in previous chapters, more particularly in connection with the teachings of Paracelsus and the Rosicrucians, and does not here need further emphasis. Those who realise the tyranny of blind authority in any branch of human inquiry, and not least in the healing art, will be the most ready to acknowledge our indebtedness to those who burst its bonds and helped to give us a science of medicine.

Classification.

It is generally acknowledged that classification is essential to the development of science. The manifold objects of our experience must be grouped into ordered classes, each characterised by certain definite marks, selected, as far as may be, according to the real nature of the things classified. Think what the Linnæan system effected for Botany, and what advance in deeper knowledge of plant-life is secured in the "natural system." What can alchemy say for itself in this regard?

It has been freely granted that the Hermetic art

was unsystematic. Even as late as the eighteenth century, Kunkel, a critic of the art, could write: "I, old man that I am, who have been occupied with chemistry for sixty years, have never yet been able to discover their fixed sulphur. . . . They are not agreed among themselves respecting the kind of sulphur. The sulphur of one is not the sulphur of the other. To that one may reply that each is at liberty to baptise his child as he likes. I agree. You may even, if you are disposed, call an ass a cow; but you will never make any one believe that your cow is an ass."

And yet there must be reservations. From the earliest times there were efforts made to classify. We remember how the philosophy of the art was based on the fourfold divisions proposed by Greek thinkers—earth, water, air, fire—dry, moist, cold, hot. Metals were distinguished from non-metals, though the marks of separation were imperfectly selected. Here is a curious example of attempts to classify in fuller detail. It is taken from *The Book of Pity*. "The distinction between animal and earthy substances is as follows: Animal substances are mercury, gold, silver, lead, copper, iron. Earthy substances are divided into two categories, living and dead. Among the living are sulphur, arsenic, sal-ammoniac, and everything which burns or melts, and of which fire can cause the spirit to depart. The second category, that of dead things, comprehends all that does not melt, or burn, or give off vapours; for example, chalk and like substances." The ground of distinction is evidently the presence or absence of combustibility, or response to the action of heat—fire is taken to be the principle

of life. The result is crude, but full of promise. The characteristic alchemist triad, Elements, Principles, Essence, though more subtle, is really much less natural, save in so far as it led up to the distinction between elements and compounds.

A Byzantine example is full of interest, not only on the score of its astrological flavour, but also, and chiefly, because of the singular medley of hits and misses. With one exception, the substances are grouped under the metals. Under lead (Saturn) appear litharge, agate, and other like materials. Under tin (Jupiter) appear coal, sulphur and white stones similar to enamel. Under iron (Mars) appear the magnet and pyrites. (A good hit.) Under gold (Sol) appear hyacinth, diamond, carbon, and the most brilliant of the precious stones. (The conjunction of diamond and carbon is striking!) Under copper (Venus) appear pearls, amethyst, bitumen, sugar, honey, myrrh, sal-ammoniac, incense. Under emerald (Mercury) appear quicksilver, amber, mastic. (This is the case in which the metal is not in the place of honour; but emerald was regarded as a metal, so that it is merely a matter of precedence.) Lastly, under silver (Luna) appear glass and white earths. The reasons for most of these groupings are obscure, but the intention is plain—to group under comprehensive heads a variety of substances which had attracted attention by special qualities or activities.

Paracelsus propounded a three-fold set of harmonies which secured wide acceptance :—

Soul	Spirit	Body
Mercury	Sulphur	Salt
Water	Air	Earth

This was a reversion to obscurantist mysticism. Fortunately more sober adepts were quietly and gradually making sounder distinctions, and learning to speak of alkalies, salts, acids, metals, and the rest, with some approach to respect for the data of actual experience. Basil Valentine, as we saw, wrote a special treatise on salts. The fact is, that in regard to classification, as with experiment and method, there was a real, though slow, advance. A basis was being found on which the science of the future could build. Let us now in the next chapter see how this building came about—how alchemy developed into modern chemistry.

CHAPTER V

TRANSITION TO MODERN CHEMISTRY

HERE is a passage from Zosimus, the oldest of the known writers on alchemy. "I saw a priest standing before an altar in form of a cup, having several steps by which it was approached. The priest answered: 'I am the priest of the sanctuary, and I am under the weight of the power which crushes me. At the break of day there came a workman who seized me, slew me with a sword, divided me into morsels; after having lifted the skin from my head, he mixed my bones with the flesh and calcined me in the fire, to teach me that the spirit is born with the body. That is the power that oppresses me?' While the priest spoke thus, his eyes became like blood, and he vomited all his flesh. I saw him mutilate himself, tear himself with his teeth and fall to the ground. Seized with terror, I awoke, reflected, and asked myself if this is really the composition of water. And I congratulated myself on having divined rightly."

Compare this symbolical jargon with the directions given in a modern manual of chemistry. Can there be a passage from one to the other? Had we not undertaken a sympathetic study of the alchemists' aims, doctrines, and methods, we should assuredly be tempted to answer in the negative. But we are

now in a position to understand that in the strange passage from Zosimus there are allusions to real operations—calcinations, fermentations, dissolutions, and the rest. It was these underlying experiences that were gradually seized upon, cleared of their obscurities, and given a place in an ordered scheme. The process was long drawn out, but inevitable. For Nature presses on men's attention fundamental likenesses and differences among her phenomena, and so suggests larger inductions and wider generalisations. The presuppositions and wayward strivings of inquirers are gradually corrected and curbed. Facts carry the day, and modern chemistry comes to the birth.

Difficulty in discovering Elements.

When a modern scientist is contemptuous of alchemy, it may be surmised that he has not adequately realised the difficulties under which the old chemists laboured. Right down to the days of the brilliant discoveries made by the greatest of chemists, Lavoisier, there were not any known fixed elements to serve as starting-points for synthesis or as goals for analysis. It was thought that all matter is endlessly transformable, backwards and forwards. The serpent biting its own tail was a legitimate symbol of the doctrine universally accepted. Hence problems that are to us quite straightforward were for the alchemists hopelessly baffling and complex.

Take a simple case mentioned by Berthelot. I quote his own statement of it. "I have a mineral of iron, say one of the oxides so widely distributed in

nature. I treat it with carbon and chalk, and I obtain metallic iron. But this in its turn, by the quick action of fire and in contact with air, or by the slow action of atmospheric agents, passes back to the state of an oxide, identical with, or analogous to, the primitive generator. Where is the primordial element, if we judge by appearances? Is it the iron which disappears so easily? Or is it the oxide which existed to start with and is found at the end? The idea of the elementary body would seem *à priori* to suit rather the last product in so far as it manifests stability and resistance to agents of every kind." * The merest tyro nowadays can give the correct answer; but the great chemist Berthelot realises how hard that was for those who had not the means of determining iron to be an element, and who did not know that the oxygen of the atmosphere was concerned in an explanation of the changes.

Or take the case which puzzled and misled even so sound an investigator as Van Helmont, when he tried to account for the growth of a plant. He put a willow weighing 5 lbs. into 200 lbs. of earth previously dried in an oven, and watered it regularly. At the end of five years he found the plant weighed 169 lbs., whereas the earth, after redrying, had lost only 2 ozs. in weight. What was he to conclude? He had not the means of knowing the real nature of water, nor of the carbon dioxide absorbed from the atmosphere. His answer, therefore, seemed to be irrefutable that the 164 lbs. of woody matter, leaves, roots, and so forth, were produced by the water. That is to say, the water to all appearance had been changed into a variety of

* *Les Origines de l'Alchimie*, p. 283.

THE HON. ROBERT BOYLE.

From an engraving by W. Holl.

[*P.* 222.

solid substances! A clever scientist was thus forced to a conclusion which was quite in harmony with alchemical doctrine, and yet grievously out of harmony with the facts. A modest amount, then, of historical imagination should enable the proud or cynical modern to realise that to be an alchemist was not necessarily to be a fool.

Discovery of the Elements—Boyle.

It will now be apparent that the crucial difference between the old and the new chemistry was the doctrine of the nature of matter. For the old, matter was indefinitely transmutable; for the new, the elements were fixed and unchangeable ultimates. Let us see, in broad outline, how the advance to the sounder view was brought about. As in almost every case of scientific discovery, the final result was not gained at a bound, but by successive steps, and by the accumulation of guiding experiences.

Boyle * was one of the first to question the old doctrine. We saw how the Greeks had decided there were four elements—earth, water, air, fire, and how Paracelsus and his school had substituted for these the three—salt, sulphur, mercury. Boyle, on the basis of his many and original experiments, was dissatisfied with both these classifications, and introduced a conception of an "element" which was not far removed from that now accepted. The alchemists regarded the metals as compounds; he inclined to the belief that they were simple. He adopted the theory

* See p. 58.

of atoms, which he regarded as small particles of different shapes and sizes, united into small " parcels " not easily separated, and contended that the alchemist elements are not simple bodies, but are built up of particles more simple than themselves. In this way he came to distinguish between an element and a compound in a manner quite opposed to the older conception, and in line with the chemical doctrine of the present day. He also realised that a true compound must not be confused with a mixture, since it involves a peculiar and intimate kind of action due to " affinities " between substances. Had the fine lead he gave been followed up, the transition period might have been much curtailed. The phlogiston theory, however, intervened, and, though by no means wholly mischievous, retarded progress in this particular direction.

Discovery of Gases.

One of the greatest bars to progress was the belief that all gaseous substances were essentially alike, differing only in degrees of purity. That is to say, the ancient doctrine of *air* as an element blocked the way to a knowledge of gases generally, and, consequently, of the part played by oxygen in the process of combustion. The men, therefore, who first solved the difficult problems presented by the constituents of the atmosphere occupy places of special honour on the scientists' roll of fame, and have the fullest right to be called the founders of modern chemistry.

Needless to say, the truth was not gained all at once. A much-neglected pioneer, John Mayow, born

in 1645, advanced far on the road. He is not even mentioned in Encyclopædias or ordinary Biographical Dictionaries, and yet he was evidently a genius who accomplished some striking results. He firmly grasped the fact that the atmosphere contained some substance or principle which was concerned in combustion, in the calcining of metals, and in the conversion of venous into arterial blood. He called it *spiritus igno-aereus*, and also, by virtue of having found it in saltpetre, *nitro-aereus*. It is singular that his discoveries did not rouse more attention. Perhaps his early death, at the age of thirty-four, not only put an end to further observations, but precluded the chance of his work becoming known.

A later scientist, Stephen Hales (1677–1761), who for years held the cure of Teddington, was more fortunate in gaining attention, for he was able to communicate his results to the Royal Society. His papers make it evident that he must have prepared a considerable number of gaseous substances—hydrogen, carbonic acid, carbonic oxide, sulphur dioxide, marsh gas, and others—but he did not break through the charmed circle of the traditional teaching. He thought that the differences between these gases were caused by the "tincturing" of air with substances which were more or less accidental. The first clear recognition of the fact that there are various kinds of gases did not come until towards the close of the eighteenth century, when Joseph Black, a professor of chemistry in Glasgow and Edinburgh, studied carbonic acid, and definitely separated it from the protean element, "air." After this advance, discoveries came more quickly. Cavendish, that eccentric genius, distinguished himself by

his accurate observations on this same gas, and also on hydrogen. His most brilliant achievement, however, was his discovery that water is composed of two gases! Another of the ancient "elements" was dethroned—another blow was levelled at the alchemist ideas of matter.

Joseph Priestley (1733–1804).

A still more revolutionary success was scored by the famous Joseph Priestley. The title of his chief work is *Experiments and Observations on Different Kinds of Air*. His chief attention at first was devoted to carbonic acid; but many other gases were detected by him, and new methods of examining them devised. It is now generally acknowledged that he merits the name of "the father of pneumatic chemistry." Thorpe asserts that he was the first to establish that the air is not a simple substance, as the alchemists believed it to be. Above all, he is now credited with the discovery of oxygen. He was experimenting with our old friend, oxidised mercury. He thus describes the fateful experiment: "On the 1st of August, 1774, I endeavoured to extract air from *mercurius calcinatus per se;* and I presently found that, by means of this lens, air was expelled from it very readily. Having got about three or four times as much as the bulk of my materials, I admitted water to it, and found that it was not imbibed by it. But what surprised me more than I can well express was, that a candle burned in this air with a remarkably vigorous flame. . . . I was utterly at a loss how to account for it."

Priestley himself, in spite of his marked originality and independence of mind, did not quite escape from the influence of alchemistic ideas. He thought of matter as built up, so to speak, of properties which could be stripped off or added. He was, moreover, sorely hindered in arriving at sound deductions by his unquestioning acceptance of the phlogiston theory. Nevertheless, his work gave a notable impulse to a reformed and expanded chemistry which was soon to banish the old ideas for ever. Let us again observe, in passing, how largely the overthrow of alchemy turned on the investigation of gases, more especially of oxygen. As Thorpe puts it, "the discovery of oxygen, and the recognition of the part it plays in the phenomena which phlogiston was invoked to explain, mark the termination of one era in chemical history and the beginning of another." This seems to be a sounder way of putting the case than Muir's when he says that Priestley's discovery "was destined to change Alchemy into Chemistry." For there were many contributing influences, as we have seen above—the greatest being, perhaps, the new spirit infused by Boyle which led to the study of chemical affinity, to more careful analysis, the use of the balance, and of quantitative methods generally. Nevertheless, Muir's enthusiasm is more than pardonable.

Lavoisier (1743–1794).

Priestley, then, was the first to recognise the existence of oxygen as a separate gas; but he did not grasp the full significance of his great discovery. The

true theory of combustion is due to the great French chemist, Lavoisier, who was murdered by the French communists in the reign of terror of the first French Revolution. Into the technical details of the methods he adopted, or of the process of combustion we need not enter; they belong rather to the history of chemistry, and we are only concerned with them so far as they led to the overthrow of alchemy. The central fact is this. All ordinary cases of burning are the results of the union of the burning substance with the oxygen of the atmosphere. Calcination is thus a kind of combustion in that the metal combines with this gas, and thereby increases its weight by the amount it takes up.

The main point to be seized is this. From his time onwards chemistry became a science of exact *quantitative* measurements. True, Lavoisier was not the originator of the use of the balance in chemical investigations; but it was his teaching that gave it an indispensable place in sound method. An example from his own use of it will serve both to illustrate its value, and also to show how it led to the rejection of an idea that had prevailed from the earliest times of Greek philosophy down to the nineteenth century.

It was believed, as we have seen, that air can be condensed to water, as in the case of "falling dew," and that water can be changed into a solid, as in Van Helmont's argument from the growing willow, or in the residue obtained when even carefully distilled water is evaporated in glass vessels. Now Lavoisier did not assent to this doctrine. He determined to put it to the test of a decisive experiment. So he distilled water in hermetically sealed glass vessels

which were weighed before and after the operation. The steps of his argument are so typical of the new methods that they may be given seriatim.

1. The solid residue (the earth) does not come from outside the vessel; for the total weight of the vessel and its contents is unchanged.

2. The earth does not come from the water; for the weight of the water is the same before and after the experiment.

3. The earth comes from the vessel, because the vessel loses in weight.

4. The earth comes *wholly* from the vessel, because the loss in weight of the vessel is practically equal to the weight of the earth formed.

Hence, Lavoisier concludes, "it follows from these experiments that the greater part, possibly the whole of the earth separated from rain-water by evaporation, is due to the solution of the vessels in which the water has been collected and evaporated."

Unchanging Elements.

The experiment just given brings us to the very core of the matter. The elements of which water is constituted can never be anything but themselves—oxygen and hydrogen. True, liquid water can become a gas or a solid—can be turned into steam or into ice. But this is only a change of *state*, not of substance; there is an alteration in the properties of the substance, but there is not a *new* substance. That different names are given to the three states—ice, water, steam—is a mere accident, due to their commonness in

nature. Thus if iron be melted we speak of it as "molten" iron; if it be heated until it is in the gaseous form, we should call it "vaporised" iron, or some similar name. We know that the substance is "iron" throughout.

The new doctrine cannot be better stated than in Lavoisier's own words, "If we apply the term elements or principles to bodies to express our idea of the last point which analysis is capable of reaching, we must admit, as elements, all substances into which we are able to reduce bodies by decomposition. Not that we are entitled to affirm that these substances which we consider as simple may not themselves be compounded of two, or even of a greater number of more simple principles; but since these principles cannot be separated, or rather, since we have not hitherto discovered the means of separating them, they are, with regard to us, simple substances, and we ought never to suppose them compounded until experiment and observation have proved them to be so." Lavoisier wrote this in 1789, but it remains substantially true. Mellor, in his *Modern Inorganic Chemistry*, quotes the passage with complete approval, and summarises it thus: "An element is a substance which, so far as we know, contains only one kind of matter."

Thus it was that for the vague, fluid ideas of chemical composition held by the old chemists there was substituted a clear notion of what such composition really involves—a peculiarly intimate union of certain quantities of different and unchanging kinds of matter. The fact that the proportions in which the combinations can take place are not haphazard, but definite, is a discovery of fundamental importance

which renders it possible to represent chemical actions by mathematically exact equations. But we need not here inquire into this further development. It is a refinement on a general principle. And the general principle, by itself, won for the new science its complete and lasting victory.

Alchemist Transmutation abandoned.

Atoms are now for us the ultimates, so far as practical chemistry is concerned. And atoms are composed of definite unchangeable kinds of matter, so far as our manipulation of them can be effective. It is insistence on this truth that constitutes the radical difference between the transmutation of metals and the fabrication of compound substances. From the early days of the Hermetic art onwards, there had been individuals who had cast doubts on the possibility of transmutation. Such intuitive sceptisicm, however, had little influence on the theory or the practice of alchemists. It was the gradual accumulation of facts, culminating in the work of Lavoisier, that at last bore all before it. No longer do adepts labour to strip from substances their supposed separable qualities, or superinduce those more desired. No longer do they search for hidden virtues and essences by the commingling of which they may speed up a natural growth towards perfection and procure the perfect metal. The modern adept goes to work in very different fashion. He starts with the knowledge that certain of his materials are unalterable. He examines the properties of these with unwearying

exactness; learns how to analyse existing compounds of them, and how to build up new ones. The ancient glamour no longer lures him on. He never expects to see his tin transmuted into silver, or his copper into gold. But he knows that there are far greater marvels to be discovered than even the most daring of the alchemists could ever imagine.

CHAPTER VI

THE OUTLOOK

THE old idea of perfecting matter by a course of natural development is dead. Are there any grounds for anticipating that the hope of transmuting it may be revived in some more defensible form? An affirmative answer to this question has been several times suggested in what has preceded; and it is fitting that a fuller consideration of the point raised should conclude our study.

Bacon, from the standpoint of his time, puts the case clearly. "It is a thing more probable, that he who knoweth well the nature of Weight, of Colour, of Pliant and Fragile in respect of the hammer, of Volatile and Fixed in regard of the fire, and the rest, may superinduce upon some metal the nature and form of gold by such mechanique as belongeth to the production of the natures afore rehearsed, than that some grains of the medicine projected should in a few moments of time turn a sea of quicksilver or other material into gold." * Bacon, therefore, is among those who conceive that alchemy has a future, and that the chances of solving its problem will be increased through the growth of knowledge and the improvement of apparatus. With the triumph of the atomic

* *Advancement of Learning*, p. 75.

theory of matter came a period of eclipse. Scientists enthusiastically concluded they had decided the question in the negative. Further discovery and reflection proved them to have been too hasty; and we find no less an authority than Faraday writing as follows: "There was a time when this fundamental doctrine of the alchemists (that of transmutation) was opposed to known analogies. It is now no longer so opposed to them, only some stages beyond their present development." * This most brilliant of modern discoverers deliberately ranges himself on the side of the transmutationists. Has anything since come to light that would again weaken the belief? Rather is the contrary to be emphatically asserted. The trend of discovery is distinctly in its favour. The rigidity of the older form of the atomic theory is rapidly disappearing, if it has not quite disappeared; and scientists are feeling their way out into worlds the very existence of which was not suspected by those who had comfortably settled down to a system of physics which was going to count the unalterable number of atoms in the universe.

The Elements are not Ultimates.

At the present time there are some eighty elements which chemists hold to be different kinds of matter, so far as existing means of distinguishing them can determine. There are, however, few, if any, authorities who would now maintain that the recognition of elements is the last word of science on the ultimate

* *Lectures on Non-Metallic Elements*, p. 106.

nature of matter. Tilden, for example, warns us against such a conclusion. "The molecular (atomic) theory has been adopted in a somewhat rigid form, not by reason of any special conviction of my own regarding its permanence as a scientific truth, but because I am satisfied by long experience that, whatever form it may ultimately assume, it is even now a most important and almost indispensable aid to teaching chemistry." * More recently Soddy, who strongly emphasises the persistence of the elements, affirming that "not without reason have the atoms been termed the foundation stones of the universe," nevertheless looks forward, as we shall see directly, to a time when science may be able to pull them to pieces and construct them. He points out that, at the dazzling temperatures in the sun and the hot stars, "dissociation of the elements into simpler forms has been imagined to be and may be taking place;" † and contents himself with recording the fact that "so far, even at the highest temperature rendered available by the use of the electric furnace, no indications of a transmutation of the elements is yet forthcoming." Whetham writes: "Some years ago the constancy of the chemical elements was, in the then state of knowledge, a law of Nature. Latterly, the phenomena of radioactivity have forced us to believe . . . that true transmutations of matter occur." ‡ Recent science, then, is far from being inimical to the hope that the elements may be reduced to some simpler kind, or kinds, of substance. And

* *Introd. to Chemical Philosophy* (1876), p. vii.
† *Matter and Energy*, p. 143.
‡ *Recent Development of Physical Science* (1904), p. 36.

what is this but to allow the possibility of transmutation? Lord Kelvin, indeed, in 1907, challenged the inferences then being drawn from radioactivity; but his objections were effectively countered in the course of the proceedings at which his pronouncement was made; and subsequent discoveries have overthrown them.

Isomerism and Allotropism.

The idea of the alchemists that qualities are separable things, to be taken from or added to substances, was erroneous. But it has its measure of truth. When two atoms of hydrogen are chemically united, there comes into being a molecule of water—a substance so different from its constituents that until quite recent times it was held to be a fundamental element. The discovery of its compound character was one of the triumphs of the new science. Now what happens when the chemical combination takes place? Do the hydrogen and oxygen atoms gain or lose certain qualities which are separable from them? Not at all. They merely manifest certain qualities which they all along possessed, but could not exercise until they were brought into this particular relation. So a man may have all the qualities of a good general; but they cannot, as such, be put into action unless he is in relation to an army.

This fact leads us to realise that, even were atoms themselves absolutely unchangeable, their apparent qualities may be altered by bringing them into new relations—new substances may appear. That is to say, there is a kind of transmutation possible by giving

new forms to the groupings of atoms. And who shall set bounds to what may be thus accomplished? Who shall say how many of the substances now called elements may not be, in reality, exceptionally stable groups of simpler constituents?

These questions are not merely academic. Chemists do actually know of cases which clearly demonstrate that form of grouping alters properties, even when the substances contain the same atoms in the same relative qualities. They have concluded that the atoms of a molecule are so definitely arranged that no two of them can change places without altering the properties of the substance. When two or more compounds are identical in their percentage composition but differ in their properties, they are said to be *isomeric* ("composed of equal parts"). Mellor gives the following example: "Ammonium nitrate and hydroxylamine nitrite are two different substances with the same ultimate composition, the same molecular weight, and both furnish nitrous oxide and water when heated. There the similarity almost ends. The general properties of the two salts are so very different that there is little room for doubt that the constitution of the molecules must be quite different."

But this principle does not refer to compounds alone; it is found to be true of the elements themselves. Certain of them may exist in two or more forms with distinctly different properties. Such forms are said to be *allotropic*. Carbon furnishes a notable example. There is the amorphous form such as is obtained from burning wood; and there are two crystalline forms, graphite or black lead, and

the diamond. Could anything be more startlingly different than the liquid, glancing, transparent diamond and the opaque blackness of the other two? And yet their ultimate atoms are absolutely the same. And the diamond "heated in the electric arc, out of contact with air, blackens and swells up into a coke-like mass." Other well-known instances are oxygen and ozone, and the differing forms of phosphorus and sulphur. In the case of sulphur, it would even seem that the number of atoms in the molecules of the allotropic forms—amorphous, plastic, crystalline—is the same!

Now these facts suggest wider applications. May it not be possible to modify simple bodies which are physically alien (so to speak) in such fashion that one may pass into the other? Oxygen and sulphur might fall into such mutual relations. Cobalt and nickel have the same atomic weights (within a fraction), are alike in most of their properties, and produce two parallel series of compounds. So, also, gold, platinum and iridium are remarkably alike, and suggest that they are constituted by the same fundamental matter with different arrangements of atoms. The outlook would seem to be not altogether hopeless. It must be granted, however, that such reciprocal genesis would have to be accomplished by some operation of quite another order than any now in our power to execute.

Natural Families of Elements.

The considerations last adduced raise a larger question on a grander scale. All the known elements

have now been fitted into a series of family groups which are themselves united by close and almost symmetrical relations. The classification is in accordance with what is called the Periodic Law. The anomalies and exceptions, which are not serious, evidence the interference of some secondary perturbations not yet discovered; but the general plan is clear, and profoundly suggestive. It is even definite enough to allow of predicting the existence of unknown elements, and describing their chief properties.

Now the outstanding fact in all this is that of gradated relationship. We find atoms united into groups of compound substances with closely related properties, and we know that the result is due to the building up of these atoms in definite proportions. And when we see that the atoms themselves fall into similar groups, possessing likewise closely related properties, it is eminently reasonable, if not compulsory, to assume that they are built up of sub-atoms. That is to say, they are not ultimate, indecomposable things, but composite; they were not always what they now are, but have come into being by a constructive process. The inference is obvious. In the great laboratory of Nature they can be made and unmade; and if scientists can discover the conditions and the means necessary, they too can make and unmake the elements. The difficulty may, as Soddy says, be prodigious; but the possibility is there. And thus a new light is thrown upon the old alchemist dictum that "Vulcan is a second nature, and imitateth that dexterously and compendiously which nature worketh by

ambages and length of time." * There is a goal for a new alchemy.

Radioactivity.

Even were we to limit ourselves to what was known at the close of last century, we should be justified in claiming that a belief in the possibility of transmutation, in a modernised sense of that term, could be rationally defended. But the case was enormously strengthened in the opening years of the present century in consequence of the astounding phenomena manifested by what are called the radioactive bodies. The story of how M. and Madame Curie discovered radium is familiar to most of us, and need not here be retold. Nor need we consider in any detail the radical modifications introduced into scientific doctrines of matter by the conclusions which the fact of radioactivity compels. Let us simply try to grasp the main facts in so far as they bear on our special subject.

In the first place, let it be clear that chemists have not given up their eighty elements; they still rightly hold to them as their working ultimates. But they can no longer point to their science as being fundamental. For atoms cannot now be considered, even from the practical standpoint, to be unchangeable. Certain of them can be actually seen, under our very eyes, in the process of slow spontaneous disintegration. The most familiar instance is that of radium, which (as Soddy says) if it is no true element, then the word "element" has no meaning. Its atoms are continuously breaking down into simpler substances. They pour forth a never-ceasing stream of energy

* Bacon, *Advancement of Learning*, p. 59.

which neither quickens nor relaxes its pace, and which is unaffected by any agents we are able to employ. And since the composition of these atoms is changing, transmutation is in process. Between the original radium and the last of the products there are some thirty transitional forms, each with its own definite characteristics!

But this is not all. Radium atoms, on the average, last for more than 2000 years. This, though relatively to us a long time, is a mere nothing in comparison with the age of the earth. How is it, then, that there are any of these atoms in existence? There must be a supply-source. What is it? Scientists are practically agreed that this is found in another radioactive body, uranium. Radium itself is a product of transmutation! Other products of the serial disintegration are helium, an inert gas, and (almost certainly) lead. Without further explication, therefore, we have here four recognised elements—uranium, radium, helium, lead—which are not only members of groups "periodically" related to each other, but are connected by a known process of transmutation. All this is strangely in agreement with what the alchemists aimed at. Who shall venture to prophesy what triumphs of structural chemistry or physics may not be won by those who are to come after us?

This question is not a rhetorical one, occurring to the mind of one who simply reflects on what others have accomplished, and gives rein to his imagination. Professor Soddy puts it. And he is a man who is distinguished for first-hand practical study of radio-activity and for solid discovery. He writes thus:

"Let us consider in the light of persent knowledge the problem of transmutation, and see what the attempt of the alchemist involved. To build up an ounce of a heavy element like gold from a lighter element like silver would require in all probability the expenditure of the energy of some hundreds of tons of coal, so that the ounce of gold would be dearly bought. On the other hand, if it were possible artificially to disintegrate an element with a heavier atom than gold and produce gold from it, so great an amount of energy would probably be evolved that the gold in comparison would be of little account. The energy would be far more valuable than gold. Although we are as ignorant as ever of how to set about transmutation, it cannot be denied that the knowledge recently gained constitutes a very great help towards a proper understanding of the problem and its ultimate accomplishment. We see clearly the magnitude of the task and the unsufficiency of even the most powerful of the means at our disposal in a way not before appreciated, and we have now a clear perception of the tremendous issues at stake. Looking backwards at the great things science has already accomplished, and at the steady growth in power and fruitfulness of scientific method, it can scarcely be doubted that one day we shall come to break down and build up elements in the laboratory as we now break down and build up compounds, and the pulses of the world will then throb with a new source of strength as immeasurably removed from any we at present control as they in turn are from the natural resources of the human savage." *

* *The Interpretation of Radium*, pp. 237, 238.

The Elixir of Life.

But what of the alchemist's hope of discovering an Elixir which should give health and longevity, if not immortality? That surely must be dismissed as an idle dream. Well, it must be acknowledged that the outlook in this regard is not nearly so hopeful as in the case for transmutation. The advances made in the healing art are wonderful, and have secured for us a longer average life. But there is little expectation of discovering some wholly new panacea like the famed Elixir. There are, indeed, not a few authorities among physicians who contend that death is not an inevitable fate, but that it is due to disease. If they are right, and if they can trace the causes of that disease—atrophy, sclerosis of the arteries, and so forth —then the remedy may be forthcoming. The general opinion, however, is that old age and death are the results of processes inherent in the organism, and therefore inevitable.

But another point of view may be taken. The alchemists linked together the ideas of the Philosopher's Stone and of the Elixir, and held that to find one would be to find the other. The Stone would give the power to transmute, and so would put men in possession of virtues and influences exceeding those of normal experience. Translate this into modern terminology. If scientists can find a key to unlock the structure of the atom, they will be in possession of boundless supplies of new forms of energy. Who knows but that in some of these forms there may be found "the life-force" which has rendered possible the whole upward impulse of organic evolution? The

speculation is a daring one. It must not claim to be more than a speculation. And yet there is nothing in it that is contrary to reason—nothing, even, that is out of harmony with positive science. And thus once again we may acknowledge that Hermetic philosophers had glimpses of possibilities which may yet be realised. For if the primal mysterious life-force can be brought under control, it cannot fail to be exploited for the healing of disease and the warding off of decay.

Conclusion.

The long story has been unfolded. A glance into the future has been ventured. What shall be our final verdict on alchemy? A superficial judge will seize on its superstitions and errors, its follies and its frauds. He will condemn. If he be a man inclined to mercy, he will temper his sentence by an expression of regret that so fanatical a devotion should have been wasted on a false and useless art. Would he decide thus in the case of astrology? If not, why not? The lore of the astrologer issued in the science of astronomy. The lore of the alchemist issued in the science of chemistry. The advantage of comparative simplicity in subject matter rested with the men who studied the phenomena of the spangled heavens. Let this fact be kept in mind, and a juster verdict will be pronounced. The errors were mostly the consequences of the extraordinary complexity and subtlety of chemical actions, and of adherence to the tenets of a misleading philosophy.

A generous and large-minded judge will disregard the follies, will thrust aside the charlatans, to fix his

attention on those nobler inquirers who in dark and difficult times experimented and observed, and who thus handed on and added to the stock of human knowledge. These were the true alchemists. It is by their work that the value of the art must be assessed. They are to be credited with that conjoining of speculative thought and laboratory practice which furnished a basis for the development of genuine science; with a host of valuable discoveries and ingenious devices; with that insight into Nature which catches glimpses of possibilities only to be realised by workers who have gained fuller knowledge and more adequate equipment.

A modest dower of human sympathy and of constructive historical imagination will enable us to set the work of the alchemists in large perspective, and so to estimate aright the amount of our debt to them. We ourselves, indeed, have passed through and beyond the narrow valleys of preconceived opinions, and have emerged on the more open mountain slopes. But let us not fail in our meed of gratitude to those who blazed the trail through the low-lying jungle. Let us apply to the Hermetic art itself, with broader reference, the words that Browning puts into the mouth of one of its most gifted, but also most erring, professors—

> "If I stoop
> Into a dark tremendous sea of cloud,
> It is but for a time; I press God's lamp
> Close to my breast; its splendour, soon or late,
> Will pierce the gloom."

THE END

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