CHAPTER I.

THE NEW PHILOSOPHY.

THE closing years of the sixteenth century saw the completion (1599) by the Company of Jesus of their *Ratio Studiorum*, which, reaching its final shape after the laborious corrections dictated by fifteen years' experience, proved its framers to be without question the most efficient schoolmasters of their time. What the average school of the early seventeenth century was like a later chapter will show; for the very best exponents of their type of education we must turn to the Jesuit colleges. Their striking success was not the consequence of the formulation of new principles, nor of the employment of novel methods. On the contrary, the Society accepted the principles and methods which were generally held by their contemporaries; the schools of the Order differed from other schools in the superlative efficiency with which the current educational doctrines were applied to practice.

We must not, then, look to the Jesuit school-room if we would observe the genesis of those ideas of reform in education which are our subject; nor, indeed, shall we find it in any school-room. Reform and change are aspects of the actual thought of the moment; by the nature of the case, schools tend to busy themselves rather with what is regarded as permanent, that is, with the approved, established thought of the past, whether immediate or remote. To be a little

"behind the times" makes for the stability of the school as for that of other institutions which go deep into social life.

We shall therefore, in the end, get closer to our subject and attain a better-proportioned view of it, if, turning for a moment from schools and ideas respecting education, we look out over a wider prospect, that intellectual life of the time from which school-reforms, as all other readjustments, were to spring.

In the early seventeenth century Scholasticism still maintained a precarious hold over the official life of the Church and of the Universities, and through these an even weaker grasp upon the schools. But with respect to the intellectual life and tendencies of the time as a whole, Scholasticism was a spent force. Whereas during the Middle Ages the disposition had been to see all Truth in a definite Theology, or in the system of thought which passed for Aristotle's, from the sixteenth century onwards contempt of the Schoolmen and of authority in things intellectual generally had become characteristic of an increasing number of men. The contempt was not always enlightened, and, therefore, was sometimes undeserved, for the newer men often flagrantly sinned, when judging their predecessors, by ignoring those very rules of enquiry and of verification which they so vehemently insisted upon in the field of their own particular studies. For them, Scholasticism chiefly meant an uncritical acceptance of principles enunciated by a few great thinkers, chief of whom was Aristotle, by which name was understood, not the preeminent philosopher revealed by more intelligent study to later times, but a partly fictitious personage, to whom much was attributed for which the real Aristotle was not responsible. The earlier revolt against authority in the religious sphere had now become an intellectual revolt in general; and, whether it is Ramus writing a new logic, or Campanella meditating a new philosophy, or Bruno fiercely inveighing against all establishments, religious, philosophic, or scientific, the note of revolt

is common to all. It is true that the official guardians of orthodoxy burned Bruno, and gave Galileo no small trouble; but retaliation of this kind was an episode only in the struggle, not a decisive battle. Men had acquired new views of Truth, and they were securing command over new avenues of approach to her, so that, as William Harvey said, "They were not so bound to their instructress, Antiquity, that they must leave their friend, Truth, in the lurch, and desert her in the sight of all men."

What this new mode of regarding Truth promised to effect may be inferred from even an incomplete enumeration of discoveries made by its assistance before the expiration of the first quarter of the seventeenth century. In 1601 died Tycho Brahe, Professor of Astronomy *and Astrology* at Prague, whose observations were embodied in a series of tables, lunar, planetary and solar, which rendered very material service to subsequent enquirers. He was succeeded by his assistant, John Kepler, who in 1609 made known the first two laws of Planetary Motion called by his name, and ten years later published the third law. The conceptions expressed in these three laws and in the thesis of Copernicus (enunciated in 1543) revolutionised Astronomy and laid the foundations of the science as it is now pursued. Galileo, too, by his brilliant advocacy of the Copernican astronomy, had become a fellow-labourer with Kepler, while he had also established the science of Mechanics and extended the range of Pure Mathematics.

Simon Stevin of Bruges, who died in 1620, made contributions to the study of fortification and of such branches of applied mathematics as Mechanics and Hydrostatics. In 1586 he had published a booklet of some seven pages in Dutch, called "The Tenth, easily showing how all calculations in every-day affairs may be done in whole numbers, not broken into fractions." If this is not, as has been declared, "the invention of the decimal system," the book certainly brought that system into the range of ordinary lay knowledge and use.

It is interesting to note that the author confidently anticipated the adoption of a decimal coinage, weights, and measures. In 1614 Napier published his *Description of Logarithms*, thus making known a discovery of incalculable importance in almost every part of mathematical science.

These great steps of progress in mathematics and the sciences more especially allied to mathematics are matched by cotemporary discoveries in the natural and physical sciences. For example, the final year of the sixteenth century saw the birth of the science of Magnetism in the publication of William Gilbert's treatise "On the Magnet, Magnetic Bodies, and that Great Magnet, the Earth." The transition from ancient to modern science is signified by the invention of the microscope in 1608, of the telescope before 1610, and, in 1620, of a thermometer by Drebbel, an invention anticipated by Galileo in the air-thermometer. Galileo, indeed, was associated with the earliest forms of all three instruments; the exact date of the invention of the telescope and the name of its inventor are not matters on which authorities agree, but in 1610 the invention was certainly known to Galileo, who, constructing an improved instrument, discovered in that year the satellites of Jupiter, and later the rings of Saturn.

Again, the studies in Anatomy which Vesalius had commenced in the first half of the preceding century received their crown prior to 1628 in the discovery of the circulation of the blood by William Harvey. Before practising in London Harvey had been a student in the University of Padua, the scene of the much earlier professorial labours of Vesalius, whose intellectual heir he may, therefore, be deemed. Vesalius had been a persistent advocate and exponent of the method of observation and experiment, and as insistent a foe to the tradition which preferred the authority of Galen, the Aristotle of Medicine. His attitude was that of Galileo, Kepler, Gilbert, Harvey and the rest whose successes are so notable in the history of science during the seventeenth century. These men

are prominent in that history; but many of their contemporaries' names are less well remembered whose contributions to knowledge belong to the common inheritance of the civilised world. There is, for example, Harriot, Sir Walter Raleigh's companion in America, who made maps illustrating the explorations in Virginia, who shares with Galileo the credit of discovering the satellites of Jupiter and the Sun-spots, and who made one of the most important contributions to the theory of algebraic equations. Mercator, the cartographer, was an elder contemporary of Harriot, who stands midway between him and van Helmont, the Flemish mystic, chemist, and physiologist, to whom we owe the term "gas." The word appeared in 1624; three years earlier the Dutchman Snell discovered the law of refraction of light.

The series is continued in the second quarter of the seventeenth century in the mathematical studies of Descartes, Fermat, and others, in the names of Horrocks, who first observed the transit of Venus in 1639, of Torricelli, who invented the barometer in 1643, of Pascal, who on the Puy de Dôme confirmed Torricelli's observations. More particularly germane to our subject are those meetings which, begun at Gresham College in 1645 and continued at Oxford, led to the foundation of the Royal Society in 1662; amongst the devotees of the New Philosophy who attended these scientific discussions in the earlier days were Boyle, Hooke, Wallis, Wilkins, Seth Ward, and William Petty. The close of the half-century was marked by the invention of the air-pump by Guericke of Magdeburg, and the construction of a second instrument by Boyle.

Even the foregoing meagre catalogue, incomplete as it is, suffices to show, by the number of scientific students mentioned, and their wide distribution over the countries of Europe, that during the period under consideration there was both a fairly general repudiation of the tradition which relied upon authority and a very considerable advance in

many directions in the knowledge of natural forces and conditions.

His intellectual eminence notwithstanding, the share of Francis Bacon in this comparative wealth of scientific enquiry, discovery, and invention, was small. Possible charges of employing a merely carping criticism, or of a want of modesty in dealing with a name unquestionably great, must here be deprecated. Of Bacon's general position as thinker and writer it would be an altogether superfluous temerity to speak; the point was settled long ago. There is, however, a community of ideas between him and the educational reformer, Comenius, sufficiently great to justify the assertion that the latter must be regarded as the pupil of the English philosopher; in other words, Bacon has had a profound, albeit indirect, influence upon the history of education by way of Comenius. This community of ideas is, perhaps, most discernible in those matters of fact and of scientific method in which Bacon was most astray; as one would expect to find, if the relationship of the two men were that here assumed. The presentment of Bacon's scientific labours immediately following is, therefore, admittedly not complete, and its standpoint is determined by the particular exposition in view.

In the first place, Bacon's actual concrete achievements in science were and, in the circumstances, could only have been small, or even trifling. The great book (or, perhaps one ought to say, the great library) which he planned he did not complete; the span of even a long and untroubled life would probably not suffice to complete it. But we have the *Advancement of Learning* (1605), with its expansion, eighteen years later, in the *De Augmentis*, and the proudly named *Novum Organum* of 1620. These, with many smaller books and tractates, reveal to us the essentials, and more, of Bacon's science and philosophy. They show, too, that their author was, first and foremost, a rhetorician endowed with a most glowing imagination. Seizing the master-ideas of the time.

and recognising their ultimate possibilities as by a prophetic insight, his rhetorical powers made it easy for him to bring these ideas and visions clearly and convincingly before the minds of ordinary men. To do these things successfully argues no small claim to greatness; but the greatness is that of the fervid orator and prophet rather than that of the man of science. Many were then reaching conclusions or perfecting discoveries which men of a later time grew to consider especially Baconian; it was Bacon's function to give a voice to these thoughts, and an interpretation to these deeds, which they would otherwise have lacked outside the small republic of learned men. His enthusiasm for Natural Science, his tireless industry in her cause, his exceptional powers of imagination and of expression made him the poet, the prophet, and the journalist of the New Philosophy.

Yet he failed to interpret accurately either the methods or the aims of cotemporary students of science. So long as he remains in the region of general expressions he reflects the views of these investigators faithfully enough, as when in the opening lines of *Novum Organum* he insists that the true method of physical science must be one of experiment and observation: or again, when he asserts, in one form or another, the characteristic thought, that the aim of physical science is the improvement of man's material condition, "the relief of man's estate." Here, for example, is a passage from the first book of the *Advancement of Learning*; Bacon is speaking of the errors which have retarded science. "But the greatest error of all the rest, is the mistaking or misplacing of the last or farthest end of knowledge: for men have entered into a desire of learning and knowledge, sometimes upon a natural curiosity, and inquisitive appetite; sometimes to entertain their minds with variety and delight; sometimes for ornament and reputation; and sometimes to enable them to victory of wit and contradiction; and most times for lucre and profession; and seldom sincerely to give a true account of their gift of

reason, to the benefit and use of men: as if there were sought in knowledge a couch, whereupon to rest a searching and restless spirit; or a terrace, for a wandering and variable mind to walk up and down with a fair prospect; or a tower of state, for a proud mind to raise itself upon; or a fort or commanding ground, for strife and contention; or a shop, for profit or sale; and not a rich storehouse, for the glory of the Creator, and the relief of man's estate."

But when these generalities, so admirably set forth, require to be brought down to the particular, there is revealed the gulf between the gorgeous rhetorician and the drab working men of science.

Except in the most general sense, the method of Bacon, and the historical or actual processes employed by scientific men are not the same. "The method of Bacon," indeed, is a phrase wanting in any very precise meaning, since he has nowhere made a clear and compact statement of its nature. But, taking that meaning of the phrase which is fairly conveyed by the *Novum Organum* and such indications of method as are scattered about the *De Augmentis*, two things may be said of the Baconian method as so inferred. First, it was intended to be of so mechanical a nature, that men of the most mediocre powers should be, in employing it, on a level with the most distinguished. "For our method of discovering the sciences merely levels men's wits, and leaves but little to their superiority, since it achieves everything by the most certain rules and demonstrations" (*Nov. Org.* I. Aph. cxxii.)—a conception which was afterwards to haunt the minds of educational innovators for many a day with strange consequences. Secondly, the strict Baconian method is unworkable, or at least was never employed with much success. He himself discovered nothing by its help; and the discoveries made by his contemporaries and successors have been made by ignoring it. That he misconceived the nature of modern scientific method appears in the nineteenth aphorism of the first book of the *Novum*

Organum: in which he contrasts his own method with that of Scholasticism: "There are, and can be but two ways of investigating and discovering truth. The one hurries on rapidly from the senses and particulars to the most general axioms, and from them, as principles and their supposed indisputable truth, derives and discovers the intermediate axioms. This is the way now in use. [The reference, of course, is to established custom, not to the doings of the pioneers.] The other constructs its axioms from the senses and particulars, by ascending continually and gradually, till it finally arrives at the most general axioms, which is the true but unattempted way." Subsequent history favours the belief that it is also the impossible way.

The truth seems to be that Bacon was very partially informed as to the doings of his scientific contemporaries. For example: Kepler had dedicated a most important book[1], containing the statement of the third of his Planetary Laws, to James I, at a time when Bacon was Lord Chancellor and Baron Verulam, yet the latter makes no mention of Kepler. In 1623 Bacon inserted this passage in the *De Augmentis*, the enlarged and Latin form of the *Advancement*: "In Arithmetic, there is still wanting a sufficient variety of short and commodious methods of calculation, especially with regard to progressions, whose use in physics is very considerable." There is not a hint here of the vastly important "short and commodious methods of calculation" which had been made possible since Napier invented logarithms in 1614, an English translation of the Latin book of that year having been published *in London* in 1618. Contrast the behaviour of the rhetorician with that of Kepler, who warmly congratulated Napier and introduced the use of logarithms into Germany; or of Briggs, the Savilian professor at Oxford, who performed a journey to Merchiston especially to make the acquaintance of the great mathematician whose discovery he made accessible to learned Europe, though the

[1] *Harmonice Mundi* (Augsburg, 1618–19).

news did not reach Bacon. Again, Bacon failed to grasp the importance of some first-rate scientific theories of which he *had* heard, his failure being due either to imperfect information, or to that sense of his own importance which made him describe himself as one who "perhaps ought to be an architect of philosophy and the sciences" (*De Aug.* VII. cp. 1). The architect, of course, could not interest himself much in the doings of masons, or even of clerks of the works. From whatever cause, Bacon permitted himself to write about "the extravagant idea of the diurnal motion of the earth, an opinion which I am convinced is most false" (*De Aug.* III. cp. 4). Similarly he undervalued the studies of Gilbert in magnetism, ranking them with the futilities of the alchemist. Gilbert's name appears several times in the *Novum Organum* in passages which illustrate another of Bacon's limitations. He despised the labours of the specialist; "men," said he, "waste all their time on probing some solitary matter, as Gilbert on the magnet, and the alchemists on gold" (*N. O.* Bk. I. Aph. lxx.). He writes elsewhere, "If anyone attempt to give himself up to things, and to discover something new, yet he will only propose and destine for his object the investigation and discovery of some one invention, and nothing more; as the nature of the magnet, the tides, the heavenly system, and the like, which appear involved in some degree of mystery, and have hitherto been treated with but little success. Now it is the greatest proof of want of skill, to investigate the nature of any object in itself alone; for that same nature, which seems concealed and hidden in some instances, is manifest and almost palpable in others, and excites wonder in the former, while it hardly attracts attention in the latter" (*N. O.* Bk. I. Aph. lxxxviii.). Certainly, there can be no philosophising worth the name, apart from the widely extended view of things which is only to be gained from the summits; but before the heights are scaled there is much humdrum work to be done on the lower levels. That work belongs to the specialist, whom Bacon