

NEW CHAPTERS IN

THE WARFARE OF SCIENCE

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XVIII. FROM MAGIC TO CHEMISTRY AND PHYSICS

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NEW CHAPTERS IN
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XVIII.
FROM MAGIC TO CHEMISTRY
AND PHYSICS.

PART I.

IN all the earliest developments of human thought we find a tendency to ascribe mysterious powers over Nature to men and women especially gifted or skilled. Survivals of this view are found to this day among savages and barbarians left behind in the evolution of civilization, and especially is this the case among the tribes of Australia, Africa, and the Pacific coast of America; even in the most enlightened nations still appear, here and there, popular beliefs, observances, or sayings, drawn from this earlier phase of thought.

Between the prehistoric savage developing this theory, and therefore endeavoring to deal with the powers of Nature by magic, and the modern man who has outgrown it, appears a long line of nations struggling upward through it. As the hieroglyphs, cuneiform inscriptions, and various other records of antiquity are read, the development of this belief can be studied in Egypt, India, Babylonia, Assyria, Persia, and Phœnicia. From these countries it came into the early thought of Greece and Rome, but especially into the Jewish and Christian sacred books; both in the Old Testament and in the New we find magic, sorcery, and soothsaying constantly referred to as realities.*

* For magic in prehistoric times and survivals of it since, with abundant citation of authorities, see Tylor, *Primitive Culture*, chap. iv; also the *Early History of Mankind*, by the same author, third edition, pp. 115 *et seq.*, also p. 380; also Andrew Lang, *Myth, Ritual, and Religion*, vol. i, chap. iv. For magic in Egypt, see Lenormant, *Chaldean Magic*, chaps. vi-viii; also Maspero, *Histoire Ancienne des Peuples de l'Orient*; and especially the citations from Chabas, *Le Papyrus Magique Harris*, in chap. vii; also Maury, *La Magie et l'Astrologie dans l'Antiquité et au Moyen Age*. For magic in Chaldea, see Lenormant as above. For examples of

The first distinct impulse which lifted mankind toward a higher view of research into natural laws was given by the philosophers of Greece. It is true that philosophical opposition to physical research was at times strong, and that even a great thinker like Socrates considered certain physical investigations as an impious intrusion into the work of the gods; it is also true that Plato and Aristotle, while bringing their thoughts to bear upon the world with great beauty and force, did much to draw mankind away from those methods which in modern times have produced the best results.

Plato developed a world in which the physical sciences had little if any real reason for existing; Aristotle, a world in which the same sciences were developed not so much by observation of what is, as of speculation on what ought to be. From the former of these two great men came into Christian theology many germs of mediæval magic, and from the latter sundry modes of reasoning which aided in the evolution of these; yet the impulse to human thought given by these great masters was of inestimable value to our race, and one legacy from them was especially precious;—the idea that a science of Nature is possible, and that the highest occupation of man is the discovery of its laws. Still another gift from them was greatest of all, for they gave scientific freedom: they laid no interdict upon new paths; they interposed no barriers to the extension of knowledge; they threatened no doom in this life or in the next against investigators on new lines; they left the world free to seek any new methods and to follow any new paths which thinking men could find.

This legacy of belief in science, of respect for scientific pursuits, and of freedom in scientific research, was especially received by the school of Alexandria, and above all by Archimedes, who began, just before the Christian era, to open new paths through the great field of the inductive sciences by observation, comparison, and experiment.*

magical powers in India, see Max Müller's *Sacred Books of the East*, vol. xvii, pp. 121 *et seq.* For a legendary view of magic in Media, see the *Zend Avesta*, Part I, p. 14, translated by Darmsteter; and for a more highly developed view, see the *Zend Avesta*, Part III, p. 239, translated by Mill. For magic in Greece and Rome, and especially in the Neoplatonic school as well as in the middle ages, see especially Maury, *La Magie et l'Astrologie*, chaps. iii–v. For various sorts of magic recognized and condemned in our sacred books, see Deuteronomy, xviii, 10, 11; and for the burning of magical books at Ephesus under the influence of St. Paul, see Acts, xix, 14. See also Ewald, *History of Israel*, Martineau's translation, fourth edition, ii, 55–63; iii, 45–51. For a very elaborate summing up of the passages in our sacred books, recognizing magic as a fact, see De Haen, "De Magia," Lips., 1775, chaps. i, ii, and iii, of first part. For general subject of magic, see Ennemoser, *History of Magic*, translated by Howitt, which, however, constantly mixes sorcery with magic proper.

* As to the beginnings of physical science in Greece, and of the theological opposition to physical science, also Socrates's view regarding certain branches as interdicted to human

The establishment of Christianity, though it began a new evolution of religion, arrested the normal development of the physical sciences for over fifteen hundred years. The cause of this arrest was twofold: First, there was created an atmosphere in which the germs of physical science could hardly grow;—an atmosphere in which all seeking for truth in Nature as truth was regarded as futile. The general belief derived from the New Testament Scriptures was, that the end of the world was at hand; that the last judgment was approaching; that all existing physical Nature was soon to be destroyed: hence, the greatest thinkers in the Church generally poured contempt upon all investigators into a science of Nature, and insisted that everything except the saving of souls was folly.

This belief appears frequently through the entire period of the middle ages, but during the first thousand years it is clearly dominant. From Lactantius and Eusebius, in the third century, pouring contempt, as we have seen, over studies in astronomy, to Peter Damian, the noted chancellor of Pope Gregory VII, in the eleventh century, declaring all worldly sciences to be “absurdities” and “fooleries,” it becomes the atmosphere of thought.*

Then, too, there was established a standard to which all science which did struggle up through this atmosphere must be made to conform—a standard which favored magic rather than science, for it was a standard of rigid dogmatism obtained from literal readings in the Jewish and Christian Scriptures. The most careful inductions from ascertained facts were regarded as wretchedly fallible when compared with any view of Nature whatever given or even hinted at in any poem, chronicle, code, apologue, myth, legend, allegory, letter, or discourse of any sort which had happened to be preserved in the literature which had come to be held as sacred.

For twelve centuries, then, the physical sciences were thus discouraged or perverted by the dominant orthodoxy. Whoever studied Nature studied it either openly to find illustrations of the sacred text, useful in the “saving of souls,” or secretly to gain the aid of occult powers, useful in securing personal advantage. Great men like Bede, Isidore of Seville, Rabanus Maurus, accepted

study, see Grote's *Greece*, vol. i, pp. 495 and 504, 505; also Jowett's introduction to his translation of the *Timæus*, and Whewell's *History of the Inductive Sciences*. For examples showing the incompatibility of Plato's methods in physical science with that pursued in modern times, see Zeller, *Plato and the Older Academy*, English translation by Alleyne and Goodwin, pp. 375 *et seq.* The supposed opposition to freedom of opinion in the “Laws” of Plato, toward the end of his life, can hardly make against the whole spirit of Greek thought.

* For the view of Peter Damian and others through the middle ages as to the futility of scientific investigation, see citations in Eicken, *Geschichte und System der mittelälterlichen Weltanschauung*, chap. vi.

the scriptural standard of science, and used it as a means of Christian edification. The views of Bede and Isidor on kindred subjects have been shown in former chapters; and typical of the view taken by Rabanus is the fact that in his great work on the Universe there are only two chapters which seem directly or indirectly to recognize even the beginnings of a real philosophy of Nature. A multitude of less-known men found warrant in Scripture for magic applied to less worthy purposes.*

But after the thousand years to which the Church, upon supposed scriptural warrant, had lengthened out the term of the earth's existence had passed, "the end of all things" seemed further off than ever; and in the thirteenth century, owing to causes which need not be dwelt upon here, came a great revival of thought, so that the forces of theology and of science seemed arrayed for a contest. On one side came a revival of religious fervor, and to this day the works of the cathedral-builders mark its depth and strength; on the other side came a new spirit of inquiry incarnate in a line of powerful thinkers.

First among these was Albert of Bollstadt, better known as Albert the Great, the most renowned scholar of his time. Fettered though he was by the methods sanctioned in the Church, dark as was all about him, he had conceived ideas of better methods and aims; his eye pierced the mists of scholasticism; he saw the light, and sought to draw the world toward it. He stands among the great pioneers of physical and natural science; he aided in giving foundations to botany and chemistry; he rose above his time and struck a heavy blow at those who opposed the possibility of human life on opposite sides of the earth; he noted the influence of mountains, seas, and forests upon races and products, so that Humboldt justly finds in his works the germs of physical geography as a comprehensive science.

But the old system of deducing scientific truth from scriptural texts was renewed in the development of scholastic theology, and ecclesiastical power acting through thousands of subtle channels was made to aid this development. The old idea of the vast superiority of theology was revived. Though Albert's main effort was to Christianize science, he was dealt with by the authorities of the Dominican order, subjected to suspicion and

* As typical examples, see the utterances of Eusebius and Lactantius regarding astronomers given in the chapter on Astronomy. For a summary of Rabanus Maurus's doctrine of physics, see Heller, *Geschichte der Physik*, vol. i, pp. 172 *et seq.* For Bede and Isidore, see the earlier chapters of this work. For an excellent statement regarding the application of scriptural standards to scientific research in the middle ages, see Kretschmer, *Die physische Erdkunde im Christlichen Mittelalter*, pp. 5 *et seq.* For the distinctions in magic recognized in the mediæval Church, see the long catalogue of various sorts given in the Abbé Migne's *Encyclopédie Théologique*, third series, article "Magie."

indignity, and only escaped persecution for sorcery by yielding to the ecclesiastical spirit of the time, and working finally in theological channels by scholastic methods.

It was a vast loss to the earth; and certainly, of all organizations that have reason to lament the pressure of ecclesiasticism which turned Albert the Great from natural philosophy to theology, foremost of all in regret should be the Christian Church, and especially the Roman branch of it. Had there been evolved in the Church during the thirteenth century a faith strong enough to accept the truths in natural science which Albert and his compeers could have given, and to have encouraged their growth, this faith and this encouragement would to this day have formed the greatest argument for proving the Church directly under divine guidance; they would have been among the brightest jewels in her crown. The loss to the Church by this want of faith and courage has proved in the long run even greater than the loss to science.*

The next great man of that age whom the theological and ecclesiastical forces of the time turned from the right path was Vincent of Beauvais. During the first half of the twelfth century he devoted himself to the study of Nature in several of her most interesting fields. To astronomy, botany, and zoölogy he gave special attention, but in a larger way he made a general study of the universe, and in a series of treatises undertook to reveal the whole field of science. But his work simply became a vast commentary on the account of creation given in the book of Genesis. Beginning with the work of the Trinity at the creation, he goes on to detail the work of angels in all their fields, and makes excursions into every part of creation, visible and invisible, but always with the most complete subordination of his thought to the literal statements of Scripture.

Could he have taken the path of experimental research, the world would have been enriched with most precious discoveries;

* For a very careful discussion of Albert's strength in investigation and weakness in yielding to scholastic authority, see Kopp, *Ansichten über die Aufgabe der Chemie von Geber bis Stahl*, Braunschweig, 1875, pp. 64 *et seq.* For a very extended and enthusiastic biographical sketch, see Pouchet. For comparison of his work with that of Thomas Aquinas, see Milman, *History of Latin Christianity*, vol. vi, p. 461. "Il était aussi très-habile dans les arts mécaniques, ce que le fit soupçonner d'être sorcier" (Sprengel, *Histoire de la Médecine*, vol. ii, p. 389). For Albert's biography treated strictly in accordance with ecclesiastical methods, see Albert the Great, by Joachim Sighart, translated by the Rev. T. A. Dickson, of the Order of Preachers, published under the sanction of the Dominican censor and of the Cardinal Archbishop of Westminster, London, 1876. How an Englishman like Cardinal Manning could tolerate among Englishmen such an unctuous glossing over of historical truth is one of the wonders of contemporary history. For choice specimens see chapters ii and iv. For one of the best and most recent summaries, see Heller, *Geschichte der Physik*, Stuttgart, 1882, vol. i, pp. 179 *et seq.*

but the force which had given wrong direction to Albert of Bollstadt, backed as it was by the whole ecclesiastical power of his time, was too strong, and in all the life labor of Vincent nothing appears of any permanent value. He reared a structure which the adaptation of facts to literal interpretations of Scripture, and the application of theological subtleties to Nature combine to make one of the most striking monuments of human error.*

But the theological spirit of the thirteenth century gained its greatest victory in the work of St. Thomas Aquinas. In him was the theological spirit of his age incarnate. Although he yielded somewhat at one period to love of natural science, it was he who finally made that great treaty or compromise which for ages subjected science entirely to theology. He it was who reared the most enduring barrier against those who in that age and in succeeding ages labored to open for science the path by its own legitimate methods toward its own noble ends.

He had been the pupil of Albert the Great, and had gained much from him. Through the earlier systems of philosophy, as they were then known, and through the earlier theologic thought, he had gone with great labor and vigor; and all his mighty powers, thus disciplined and cultured, he brought to bear in making a treaty or truce which was to give theology permanent supremacy over science.

The experimental method had already been practically initiated; Albert of Bollstadt and Roger Bacon had begun their work in accordance with its methods; but St. Thomas gave all his thoughts to bringing science again under the sway of theological methods and ecclesiastical control. In his commentary on Aristotle's treatise upon Heaven and Earth, he gave to the world a striking example of what his method could produce; illustrating all the evils which arise in combining theological reasoning and literal interpretation of Scripture with scientific facts, and this work remains to this day a monument of scientific genius perverted by theology.†

The ecclesiastical power of the time hailed him as a deliverer; it was claimed that miracles were vouchsafed, proving that the blessing of Heaven rested upon his labors; and among the legends embodying this claim is that given by the Bollandists and immortalized by a renowned painter. The great philosopher and saint is represented in the habit of his order, with book and pen in hand, kneeling before the image of Christ crucified, and as he kneels the

* For Vincent de Beauvais, see *Études sur Vincent de Beauvais*, par l'Abbé Bourgeat, chaps. xii, xiii, and xiv; also Pouchet, *Histoire des Sciences Naturelles au Moyen Age*, Paris, 1853, pp. 470 *et seq.*; also other histories cited hereafter.

† For citations showing this subordination of science to theology, see Eicken, chap. vi.

image thus addresses him: "Thomas, thou hast written well concerning me; what price wilt thou receive for thy labor?" The myth-making faculty of the people at large was also brought into play. According to a wide-spread and circumstantial legend, Albert, by magical means, created an android—an artificial man, living, speaking, and answering all questions with such subtlety that St. Thomas, unable to answer its reasoning, broke it to pieces with his staff.

To this day historians of the Roman Church like Rohrbacher, and historians of science like Pouchet, find it convenient to propitiate the Church by dilating upon the glories of St. Thomas Aquinas in thus making an alliance between religious and scientific thought, and laying the foundations for a "sanctified science"; but the unprejudiced historian can not indulge in this enthusiastic view: the results both for the Church and for science have been most unfortunate. It was a wretched delay in the evolution of fruitful thought; for the first result of this great man's great compromise was to close for ages that path in science which above all others leads to discoveries of value—the experimental method—and to reopen that old path of mixed theology and science which, as Hallam declares, "after three or four hundred years had not untied a single knot or added one unequivocal truth to the domain of philosophy"—the path which, as all modern history proves, has ever since led only to delusion and evil.*

The theological path thus opened by these strong men became the main path for science during ages, and it led the world ever further and further from any fruitful fact or useful method.

* For the work of Aquinas, see his *Liber de Cœlo et Mundo*, section xx; also, *Life and Labors of St. Thomas of Aquin*, by Archbishop Vaughan, pp. 459 *et seq.* For his labors in natural science, see Hoefer, *Histoire de la Chimie*, Paris, 1843, vol. i, p. 381. For theological views of science in the middle ages, and rejoicing thereat, see Pouchet, *Hist. des Sci. Nat. au Moyen Age*, *ubi supra*. Pouchet says: "En général au milieu du moyen âge les sciences sont essentiellement chrétiennes, leur but est tout-à-fait religieux, et elles semblent beaucoup moins s'inquiéter de l'avancement intellectuel de l'homme que de son salut éternel." Pouchet calls this "conciliation" into a "harmonieux ensemble" "la plus glorieuse des conquêtes intellectuelles du moyen âge." Pouchet belongs to Rouen, and the shadow of Rouen Cathedral seems thrown over all his history. See, also, l'Abbé Rohrbacher, *Hist. de l'Église Catholique*, Paris, 1858, vol. xviii, pp. 421 *et seq.* The abbé dilates upon the fact that "the Church organizes the agreement of all the sciences by the labors of St. Thomas of Aquin and his contemporaries." For the complete subordination of science to theology by St. Thomas, see Eicken, chap. vi. For the theological character of science in the middle ages, recognized by a Protestant philosophic historian, see the well-known passage in Guizot, *History of Civilization in Europe*; and by a noted Protestant ecclesiastic, see Bishop Hampden's *Life of Thomas Aquinas*, chaps. xxxvi, xxxvii; see also Hallam, *Middle Ages*, chap. ix. For dealings of Pope John XXII, of the Kings of France and England, and of the Republic of Venice, see Figuier, *L'Alchimie et les Alchimistes*, pp. 140, 141, where, in a note, the text of the bull *Spondent Pariter* is given. For popular legends regarding Albert and St. Thomas, see Elephas Levi, *Hist. de la Magie*, chap. v.

Roger Bacon's investigations already begun were discredited; worthless mixtures of scriptural legends with imperfectly authenticated physical facts took their place. Thus it was that for twelve hundred years the minds in control of Europe regarded all real science as *futile*, and diverted the great current of earnest thought into theology.

The next stage in this evolution was the development of an idea which acted with great force throughout the middle ages—the idea that science is *dangerous*. As we have seen in other chapters, there was evolved more and more a vivid sense of the interference of Satan with human affairs, and especially of the interference of the ancient gods whom St. Paul had explicitly declared to be devils, and who were naturally indignant at their dethronement. More and more suspicion attached to all men who attempted anything in the development of science. The old scriptural warrant for the existence of sorcery and magic was brought in as a powerful argument against such men. The conscience of the time, therefore, acting in obedience to the highest authorities in the Church, and, as was supposed, in defense of religion, brought out a missile which it hurled against scientific investigators with deadly effect; the mediæval battle-fields of thought were strewn with such; it was the charge of sorcery and magic—of unlawful compact with the devil. This missile was effective. We find it used against every great investigator of Nature in those times and for ages after. The list of great men in those centuries charged with magic, as given by Naudé, is astounding; it includes every man of real mark, and in the midst of them stands one of the most thoughtful popes, Sylvester II (Gerbert), and the foremost of mediæval thinkers on natural science, Albert the Great. It came to be the accepted idea that as soon as a man conceived a wish to study the works of God his first step must be a league with the devil.*

The first great thinker who, in spite of some stumbling into theologic pitfalls, persevered in a truly scientific path, was Roger Bacon. His life and works seem until recently to have been generally misunderstood: he was formerly ranked as a superstitious alchemist who happened upon some inventions, but more recent investigation has shown him to be one of the great masters in the evolution of human thought. The advance of sound historical judgment seems likely to bring the fame of the two who bear the name of Bacon nearer to equality. Bacon of the chancellor-

* For the charge of magic against scholars and others, see Naudé, *Apologie pour les grands hommes soupçonnés de Magie, passim*; also, Maury, *Hist. de la Magie, troisième édit.*, pp. 214, 215; also, Cuvier, *Hist. des Sciences Naturelles*, vol. i, p. 396. For a circumstantial account of this charge of magic against Pope Boniface VIII, see Milman, *Latin Christianity*, Book XII, chap. iii.

ship and of the *Novum Organum* may not wane, but Bacon of the prison-cell and the *Opus Major* steadily approaches him in brightness.

More than three centuries before Francis Bacon advocated the experimental method, Roger Bacon practiced it, and the results as now revealed are wonderful. He wrought with power in many sciences, and his knowledge was sound and exact. By him, more than by any other man of the middle ages, was the world brought into the more fruitful paths of scientific thought—the paths which have led to the most precious inventions; and among these are clocks, lenses, burning specula, telescopes, which were given by him to the world, directly or indirectly. In his writings are found formulæ for extracting phosphorus, manganese, and bismuth. It is even claimed, with much appearance of justice, that he investigated the power of steam, and he seems to have very nearly reached some of the principal doctrines of modern chemistry. But it should be borne in mind that his *method* of investigation was even greater than its *results*.^{*} In an age when theological subtilizing was alone thought to give the title of scholar, he insisted on *real* reasoning and the aid of natural science by mathematics; in an age when experimenting was sure to cost a man his reputation, and was likely to cost him his life, he insisted on experimenting, and braved all its risks. Few greater men have lived. As we read the sketch given by Whewell of Bacon's process of reasoning regarding the refraction of light, he seems divinely inspired.

On this man came the brunt of the battle. The most conscientious men of his time thought it their duty to fight him, and they fought him steadily and bitterly. His sin was not disbelief in Christianity, not want of fidelity to the Church, not even dissent from the main lines of orthodoxy; on the contrary, he showed in all his writings a desire to strengthen Christianity, to build up the Church, and to develop orthodoxy. He was attacked and condemned mainly because he did not believe that philosophy had become complete, and that nothing more was to be learned; he was condemned, as his opponents expressly declared, "on account of certain suspicious novelties"—"*propter quasdam novitates suspectas.*"

Upon his return to Oxford, about 1250, the forces of unreason beset him on all sides. Greatest of all his enemies was Bonaventura. This enemy was the theologic idol of the period: the learned world knew him as the "seraphic Doctor"; Dante gave him an honored place in the great poem of the middle ages; the Church finally enrolled him among the saints. By force of great ability in theology he had become in the middle of the thirteenth century general of the Franciscan order; thus, as Bacon's master,

his hands were laid heavily on the new teaching, so that in 1257 the troublesome monk was forbidden to lecture; all men were solemnly warned not to listen to his teaching, and he was ordered to Paris, to be kept under surveillance by the monastic authorities. Herein was exhibited another of the myriad examples showing the care exercised over scientific teaching by the Church. The reasons for thus dealing with Bacon were evident: First, he had dared attempt scientific explanations of natural phenomena, which, under the mystic theology of the middle ages, had been referred simply to supernatural causes. Typical was his explanation of the causes and character of the rainbow. It was clear, cogent, a great step in the right direction as regards physical science: but there, in the book of Genesis, stood the time-honored legend regarding the origin of the rainbow, supposed to have been dictated immediately by the Holy Spirit; and, according to that, the "bow in the cloud" was not the result of natural laws, but a "sign" arbitrarily placed in the heavens for the simple purpose of assuring mankind that there should not be another universal deluge.

But this was not the worst: another theological idea was arrayed against him,—the idea of satanic intervention in science; hence he was attacked with that goodly missile which with the epithets "infidel" and "atheist" has decided the fate of so many battles—the charge of magic and compact with Satan.

He defended himself with a most unfortunate weapon—a weapon which exploded in his hands and injured him more than the enemy. For he argued against the idea of compacts with Satan, and showed that much which is ascribed to demons results from natural means. This added fuel to the flame; to limit the power of Satan was deemed hardly less impious than to limit the power of God.

The most powerful protectors availed him little. His friend Guy Foulkes, having in 1265 been made pope under the name of Clement IV, shielded Bacon for a time; but the fury of the enemy was too strong, and when he made ready to perform a few experiments before a small audience, we are told that all Oxford was in an uproar. It was believed that Satan was about to be let loose. Everywhere priests, monks, fellows, and students rushed about, their garments streaming in the wind, and everywhere rose the cry, "Down with the magician!" and this cry, "Down with the magician!" resounded from cell to cell, and from hall to hall.

Another weapon was also used upon the battle-fields of science in that time with much effect. The Arabs had made many noble discoveries in science, and Averroes had, in the opinion of many, divided the honors with St. Thomas Aquinas; these facts gave

the new missile—it was the epithet “Mohammedan”—this too was flung with effect at Bacon.

The attack now began to take its final shape. The two great religious orders, Franciscan and Dominican, then in all the vigor of their youth, vied with each other in fighting the new thought in chemistry and physics. St. Dominic solemnly condemned research by experiment and observation; the general of the Franciscan order took similar ground. In 1243 the Dominicans interdicted every member of their order from the study of medicine and natural philosophy, and in 1287 this interdiction was extended to the study of chemistry.

In 1278 the authorities of the Franciscan order, assembled at Paris, solemnly condemned Bacon's teaching, and the general of the Franciscans, Jerome d'Ascoli, afterward Pope, threw him into prison, where he remained for fourteen years. Though Pope Clement VI had protected him, Popes Nicholas III and IV, by virtue of their infallibility, decided that he was too dangerous to be at large, and he was only released at the age of eighty, but a year or two before death placed him beyond the reach of his enemies. How deeply the struggle had racked his mind may be gathered from that last affecting declaration of his, “Would that I had not given myself so much trouble for the love of science!”

The attempt has been made by sundry champions of the Church to show that some of Bacon's utterances against ecclesiastical and other corruptions in his time were the main cause of the severity which the Church authorities exercised against him. This helps the Church but little, even if it be well based, but it is not well based. That some of his utterances of this sort made him enemies is doubtless true, but the charges on which St. Bonaventura silenced him, and Jerome of Ascoli imprisoned him, and successive popes kept him in prison for fourteen years, were “dangerous novelties” and suspected sorcery.

Sad is it to think of what this great man might have given to the world had ecclesiasticism allowed the gift. He held the key of treasures which would have freed mankind from ages of error and misery. With his discoveries as a basis, with his method as a guide, what might not the world have gained! Nor was the wrong done to that age alone; it was done to this age also. The nineteenth century was robbed at the same time with the thirteenth. But for that interference with science the nineteenth century would be enjoying discoveries which will not be reached before the twentieth century. Thousands of precious lives shall be lost in this century, tens of thousands shall suffer discomfort, privation, sickness, poverty, ignorance, for lack of discoveries and methods which, but for this mistaken dealing

with Roger Bacon and his compeers, would now be blessing the earth.

In two recent years sixty thousand children died in England and in Wales of scarlet fever; probably quite as many died in the United States. Had not Bacon been hindered, we should have had in our hands, by this time, the means to save two thirds of these victims; and the same is true of typhoid, typhus, cholera, and that great class of diseases of whose physical causes science is just beginning to get an inkling. Put together all the efforts of all the atheists who have ever lived, and they have not done so much harm to Christianity and the world as has been done by the narrow-minded, conscientious men who persecuted Roger Bacon, and closed the path which he gave his life to open.

But despite the persecution of Bacon and the defection of those who ought to have followed him, champions of the experimental method rose from time to time during the succeeding centuries. We know little of them personally; our main knowledge of their efforts is derived from the endeavors of their persecutors.

In 1317 Pope John XXII issued his bull, *Spondent pariter*, leveled at the alchemists, but really dealing a terrible blow at the beginnings of chemical science. That many alchemists were knavish is no doubt true, but no infallibility in separating the evil from the good was shown by the papacy in this matter. In this and in sundry other bulls and briefs we find Pope John, by virtue of his infallibility as the world's instructor in all that pertains to faith and morals, condemning real science and pseudo-science alike. In two of these documents, supposed to be inspired by wisdom from on high, he complains that both he and his flock are in danger of their lives by the arts of sorcerers; he declares that such sorcerers can send devils into mirrors and finger-rings, and kill men and women by a magic word; that they had tried to kill him by piercing his waxen image with needles, in the name of the devil. He, therefore, called on all rulers, secular and ecclesiastical, to hunt down the miscreants who thus afflicted the faithful, and he especially increased the powers of inquisitors in various parts of Europe for this purpose.

The impulse thus given to childish fear and hatred against the investigation of Nature was felt for centuries. More and more chemistry came to be known as one of the "seven devilish arts."

These declarations of Pope John were echoed for generation after generation, until nearly three hundred years later there came the yet more terrible bull of Pope Innocent VIII, known as *Summis Desiderantes*, which let inquisitors loose upon Germany, and armed them with the *malleus maleficarum*, to torture and destroy men and women by tens of thousands for sorcery and magic.

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In two recent years sixty thousand children died in England and in Wales of scarlet fever; probably quite as many died in the United States. Had not Bacon been hindered, we should have had in our hands, by this time, the means to save two thirds of these victims; and the same is true of typhoid, typhus, cholera, and that great class of diseases of whose physical causes science is just beginning to get an inkling. Put together all the efforts of all the atheists who have ever lived, and they have not done so much harm to Christianity and the world as has been done by the narrow-minded, conscientious men who persecuted Roger Bacon, and closed the path ~~which he was following~~.

But despite the persecutions who ought to have followed method rose from time to time. We know little of them personally, but the progress of science is derived from the efforts of these men.

In 1317 Pope John XXI leveled at the alchemists, but the beginnings of chemical science. Knavery is no doubt true, but evil from the good was shown. This and in sundry other bulls the virtue of his infallibility as it pertains to faith and morals, co-exists with science alike. In two of these bulls he warned that those who are in danger of their lives by that such sorcerers can send their souls to hell, and tried to kill him by piercing his name of the devil. He, therefore, ecclesiastical, to hunt down the faithful, and he especially in various parts of Europe for the

The impulse thus given to the investigation of Nature was fruitful. Chemistry came to be known as

These declarations of Pope after generation, until nearly came the yet more terrible bull *Summis Desiderantes*, which led and armed them with the means to destroy men and women by the magic.

Under such guidance the secular rulers were naturally vigorous in the same policy. In 1380 Charles V of France forbade the possession of furnaces and apparatus necessary for chemical processes. Under this law the chemist John Barrillon was thrown into prison, and it was only by the greatest effort that his life was saved. In 1404 Henry IV of England issued a similar decree, and in 1418 the Republic of Venice followed these examples.

But champions of science still pressed on. The judicial torture and murder of Antonio de Dominis were not simply for heresy; his investigations in the phenomena of light were an additional crime. Pierre de la Ramée fell in the massacre of St. Bartholomew as a heretic, but his teachings had previously been stopped by a royal edict, sought by the Church on account of his breaking away from the old theological methods.*

* For an account of Bacon's treatise, *De Nullitate Magiæ*, see Hoefer. For the uproar caused by Bacon's teaching at Oxford, see Kopp, *Geschichte der Chemie*, Braunschweig, 1343, vol. i, p. 63; and for a somewhat reactionary discussion of Bacon's relation to the progress of chemistry, see a recent work by the same author, *Ansichten über die Aufgabe der Chemie*, Braunschweig, 1874, pp. 85 *et seq.*; also, for an excellent summary, see Hoefer, *Hist. de la Chimie*, vol. i, pp. 368 *et seq.* For probably the most thorough study of Bacon's general works in science, and for his views of the universe, see Prof. Werner, *Die Kosmologie und allgemeine Naturlehre des Roger Baco*, Wien, 1879. For summaries of his work in other fields, see Whewell, vol. i, pp. 367, 368; Draper, p. 438; Saisset, *Descartes et ses Précurseurs*, deuxième édition, pp. 397 *et seq.*; Nourrisson, *Progrès de la Pensée humaine*, pp. 271, 272; Sprengel, *Histoire de la Médecine*, Paris, 1865, vol. ii, p. 397; Cuvier, *Histoire des Sciences Naturelles*, vol. i, p. 417. As to Bacon's orthodoxy, see Saisset, pp. 53, 55. For special examination of causes of Bacon's condemnation, see Waddington, cited by Saisset, p. 14. On Bacon as a sorcerer, see Featherstonhaugh's article in *North American Review*. For a brief but admirable statement of Roger Bacon's relation to the world in his time, and of what he might have done had he not been thwarted by theology, see Döllinger, *Studies in European History*, English translation, London, 1890, pp. 178, 179. For a good example of the danger of denying the full power of Satan, even in much more recent times and in a Protestant country, see account of treatment of Bekker's *Monde Enchanté* by the theologians of Holland, in Nisard, *Histoire des Livres Populaires*, vol. i, pp. 172, 173. Kopp, in his *Ansichten*, pushes criticism even to some skepticism as to Roger Bacon being the discoverer of many of the things generally attributed to him; but, after all deductions are carefully made, enough remains to make Bacon the greatest benefactor to humanity during the middle ages. For Roger Bacon's deep devotion to religion and the Church, see citation and remarks in Schneider, *Roger Bacon*, Augsburg, 1873, p. 112; also, citation from the *Opus Majus* in Eicken, chap. vi. On Bacon as a "Mohammedan," see Saisset, p. 17. For the interdiction of studies in physical science by the Dominicans and Franciscans, see Henri Martin, *Histoire de France*, vol. iv, p. 283. For the suppression of chemical teaching by the Parliament of Paris, see Henri Martin, *Histoire de France*, vol. xii, pp. 14, 15. For proofs that the world is steadily working toward great discoveries as to the cause and prevention of zymotic diseases and of their propagation, see Beale's *Disease Germs*, Baldwin Latham's *Sanitary Engineering*, Michel Lévy's *Traité d'Hygiène Publique et Privée*. For a summary of the bull *Spondent pariter*, and for an example of injury done by it, see Schneider, *Geschichte der Alchemie*, p. 160; and for a studiously moderate statement, Milman, *Latin Christianity*, Book XII, chap. vi. For character and general efforts of John XXII, see Lea, *Inquisition*, iii, 436, also 452 *et seq.* For the character of the two papal

To question the theological view of physical science was, even long after the close of the middle ages, exceedingly perilous. We have seen in this chapter how one of Roger Bacon's unpardonable offenses was his argument against the efficacy of magic, and in chapters preceding how centuries afterward Wyer, Flade, Bekker, and a multitude of other investigators and thinkers suffered confiscation of property, loss of position, and even torture and death, for similar views. I will refer, then, to but one more case as typical.

In the last year of the sixteenth century the persecutions for witchcraft and magic were especially cruel in the western districts of Germany, the main instrument in them being Binsfeld, Suffering Bishop of Treves.

At that time Cornelius Loos was a professor at the university of that city. He was a devoted churchman, and one of the most brilliant opponents of Protestantism, but he finally saw through the prevailing belief regarding occult powers, and in an evil hour for himself embodied his idea in a book entitled "True and False Magic." The book, though earnest, was temperate, but this helped him and his cause not at all. The texts of Scripture clearly sanctioning belief in sorcery and magic stood against him, and these had been confirmed by the infallible teachings of the Church and the popes from time immemorial; the book was stopped in the press, the manuscript confiscated, and Loos thrown into a dungeon.

The inquisitors having wrought their will upon him, in the spring of 1593 he was brought out of prison, forced to recant on his knees before the assembled dignitaries of the Church, and thenceforward kept constantly under surveillance, and at times in prison. Even this was considered too light a punishment, and his arch-enemy, the Jesuit Del Rio, declared that but for his death by plague he would have been finally sent to the stake. His manuscript, hidden away in the archives at Treves, was supposed to be lost until within the present decade. After three centuries what remains of it has been brought to light by an American scholar.*

briefs, see Rydberg, p. 177. For the Bull *Summis Desiderantes*, see previous chapters of this work. For Antonio de Dominis, see Montucla, *Hist. des Mathématiques*, vol. i, p. 705, Humboldt, *Cosmos, Libri*, vol. iv, pp. 145 *et seq.*

* Prof. George Lincoln Burr, of Cornell University, whose copy of Loos's MS. is now in the library of that institution. For a full account of the discovery and its significance, see the *New York Evening Post* for November 13, 1886. The facts regarding the after-life of Loos, were discovered by Prof. Burr in the archives at Brussels. For Weyer, Flade, Bekker, and others, see the chapters of this work on Demoniical Possession and Insanity, and Diabolism and Hysteria.

PART II.

WE have seen thus far, first, how such men as Eusebius, Lactantius, and their compeers, discouraged scientific investigation as futile; next, how such men as Albert the Great, St. Thomas Aquinas, and the multitude who followed them, turned the main current of mediæval thought from science to theology; and, finally, how such Church authorities as Popes John XXII and Innocent VIII, and the heads of the great religious orders, endeavored to crush what was left of scientific research as dangerous.

Yet, injurious as all this was to the evolution of science, there was developed something far more destructive; and this was the influence of mystic theology, penetrating, permeating, sterilizing nearly every branch of science for hundreds of years. Among the forms taken by this development in the earlier middle ages we find a mixture of physical science with a pseudo-science obtained from texts of Scripture. In compounding this mixture, Jews and Christians vied with each other. In this process the sacred books were used as a fetich; every word, every letter, being considered to have a divine and hidden meaning. By combining various scriptural letters in various abstruse ways, new words of prodigious significance in magic were obtained, and among them the great word embracing the seventy-two mystical names of God—the mighty word “*Schemhamphoras*.” Why should men seek knowledge by observation and experiment in the book of Nature, when the book of Revelation opened such treasures to the ingenious believer?

So, too, we have ancient mystical theories of number which the theological spirit had made Christian, usurping an enormous place in mediæval science. The sacred power of the number three was seen in the Trinity; in the three main divisions of the universe—the empyrean, the heavens, and the earth; in the three angelic hierarchies; in the three choirs of seraphim, cherubim, and thrones; in the three of dominions, virtues, and powers; in the three of principalities, archangels, and angels; in the three orders in the Church—bishops, priests, and deacons; in the three classes—the baptized, the communicants, and the monks; in the three degrees of attainment—light, purity, and knowledge; in the three theological virtues—faith, hope, and charity—and in much else. All this was brought into a theologico-scientific relation, then and afterward, with the three dimensions of space; with the three divisions of time—past, present, and future; with the three realms of the visible world—sky, earth, and sea; with the three constituents of man—body, soul, and spirit; with the threefold enemies of man—the flesh, the world, and the devil; with the

three kingdoms in Nature—mineral, vegetable, and animal; with “the three colors”—red, yellow, and blue; with “the three eyes of the honey-bee”—and with a multitude of other analogues equally precious. The sacred power of the number seven was seen in the seven golden candlesticks and the seven churches in the Apocalypse; in the seven cardinal virtues and the seven deadly sins; in the seven liberal arts and the seven devilish arts, and, above all, in the seven sacraments. And as this proved in astrology that there could be only seven planets, so it proved in alchemy that there must be exactly seven metals in the *electrum magicum*. The twelve apostles were connected with the twelve signs in the zodiac, and with much in physical science. The seventy-two disciples, the seventy-two interpreters of the Old Testament, the seventy-two mystical names of God, were connected with the supposed fact in anatomy that there were seventy-two joints in the human frame.

Then, too, there were revived such theologic and metaphysical substitutes for scientific thought as the declaration that the perfect line is a circle, and hence that the planets must move in absolute circles—a statement which led astronomy astray even when the great truths of the Copernican theory were well in sight; also, the declaration that Nature abhors a vacuum, a statement which led physics astray until Torricelli made his experiments.

In chemistry we have the same theologic tendency to magic, and as a result a muddle of science and theology, which from one point of view seems blasphemous, and from another idiotic, but which none the less sterilized the field of physical investigation for ages. That debased Platonism which had been such an important factor in the evolution of Christian theology from the earliest days of the Church continued its work. As everything in inorganic Nature was supposed to have spiritual significance, the doctrines of the Trinity and Incarnation were turned into an argument in behalf of the philosopher's stone: arguments for the scheme of redemption and for transubstantiation suggested others of similar construction to prove the transmutation of metals; the doctrine of the resurrection of the human body was by similar mystic jugglery connected with the processes of distillation and sublimation. Even after the middle ages were past strong men seem unable to break away from such reasoning as this;—among them such leaders as Basil Valentine in the fifteenth century, Agricola in the sixteenth, and Van Helmont in the seventeenth.

The greatest theologians aided in developing the fetichism in which much of this pseudo-science was grounded. One question largely discussed was, whether at the redemption it was necessary for God to take the human form. Thomas Aquinas answered that it was necessary, but William Occam and Duns Scotus an-

swered that it was not; that God might have taken the form of a stone, or of a log, or of a beast. The possibilities opened to wild substitutes for science by this sort of reasoning were infinite. Men have often wondered how it was that the Arabians accomplished so much in scientific discovery as compared with Christian investigators: the reason is not far to seek; the Arabians were comparatively free from these mystic allurements, these theologic modes of thought which in Christian Europe flickered in the air on all sides, luring men into paths which led no-whither.

Strong investigators like Arnold de Villanova, Raimond Lully, Basil Valentine, Paracelsus, and their compeers, were thus drawn far out of the only paths which led to fruitful truths. In a work generally ascribed to Arnold of Villanova, the student is told that in mixing his chemicals he must repeat the psalm *Exsurge Domine*, and that on certain chemical vessels must be placed the last words of Jesus on the cross. Vincent de Beauvais insists that as the Bible declares that Noah, when five hundred years old, had children born to him, he must have possessed alchemical means of preserving life; and much later Dickinson insists that the patriarchs generally must have owed their long lives to such means. It was loudly declared that the reality of the philosopher's stone was proved by the words of St. John in the Revelation, "To the victor I will give a white stone." The reasonableness of seeking to develop gold out of the baser metals was for many generations based upon the doctrine of the resurrection of the physical body, which, though explicitly denied by St. Paul, had become a part of the creed of the Church. Martin Luther was especially drawn to believe in the alchemistic doctrine of transmutation by this analogy. The Bible was everywhere used, both among Protestants and Catholics, in support of these mystic adulterations of science, and one writer, as late as 1751, based his alchemistic arguments on more than a hundred passages of Scripture. As an example of this sort of reasoning, we have a proof that the elect will preserve the philosopher's stone until the last judgment, drawn from a passage in St. Paul's Epistle to the Corinthians, "This treasure have we in earthen vessels."

The greatest thinkers devoted themselves to adding new ingredients to this strange mixture of scientific and theologic thought; the Catholic philosophy of Thomas Aquinas, the Protestant mysticism of Jacob Boehme, and the alchemistic reveries of Basil Valentine were all cast into this seething mass.

And when alchemy in its old form had been discredited, we find scriptural arguments no less perverse and even comical used on the other side. As an example of this, just before the great discoveries by Stahl, we find the valuable scientific efforts of Becher opposed with the following syllogism: "King Solomon,

according to the Scriptures, possessed the united wisdom of heaven and earth; but King Solomon knew nothing about alchemy (or chemistry in the form which then existed), and sent his vessels to Ophir to seek gold, and levied taxes upon his subjects; *ergo* alchemy (or chemistry) has no reality or truth." And we find that Becher is absolutely turned away from his labors, and obliged to devote himself to proving that Solomon used more money than he possibly could have obtained from Ophir or his subjects, and therefore that he must have possessed a knowledge of chemical methods and the philosopher's stone as the result of them.*

Of the general reasoning enforced by theology regarding physical science, every age has shown examples; yet out of them all I will select but two, and I present these because they show how this mixture of theological with scientific ideas took hold upon the strongest supporters of better reasoning even after the power of mediæval theology seemed broken.

The first of these examples is Melancthon. He was the scholar of the Reformation, and justly won the title "Preceptor of Germany"; his mind was singularly open, his sympathies broad, and his freedom from bigotry drew down upon him that wrath of Protestant heresy-hunters which embittered the last years of his life and tortured him upon his death-bed. During his career at the University of Wittenberg he gave a course of lectures on physics. In this he dwells upon scriptural texts as affording sci-

* For an extract from Agrippa's *Occulta Philosophia* giving examples of the way in which mystical names were obtained from the Bible, see Rydberg, *Magic of the Middle Ages*, pp. 143 *et seq.* For the germs of many mystic beliefs regarding number and the like, which were incorporated into mediæval theology, see Zeller, *Plato and the Older Academy*, English translation pp. 254 and 572, and elsewhere. As to the connection of spiritual things with inorganic Nature in relation to chemistry, see Eicken, p. 634. On the injury to science wrought by Platonism acting through mediæval theology, see Hoefer, *Histoire de la Chimie*, vol. i, p. 90. As to the influence of mysticism upon strong men in science, see Hoefer; also Kopp, *Geschichte der Alchemie*, vol. i, p. 211. For a very curious Catholic treatise on sacred numbers, see the Abbé Auber, *Symbolisme Religieux*, Paris, 1870; and for an equally important Protestant work, see Samuell, *Seven the Sacred Number*, London, 1887. It is interesting to note that the latter writer, having been forced to give up the seven planets, consoles himself with the statement that "The earth is the seventh planet, counting from Neptune and calling the asteroids one" (see p. 426). For the *electrum magicum*, the seven metals composing it, and its wonderful qualities, see extracts from Paracelsus's writings in Hartman's *Life of Paracelsus*, London, 1887, pp. 169 *et seq.* For Basil Valentine's view, see Hoefer, vol. i, pp. 453-465; Schmieder, *Geschichte der Alchemie*, pp. 197-209; *Allgemeine deutsche Biographie*, article Basilius. For the discussions referred to on possibilities of God assuming forms of stone, or log, or beast, see Lippert, *Christenthum, Volksglaube, und Volksbrauch*, pp. 372, 373, where citations are given, etc. For the syllogism regarding Solomon, see Figuiet, *L'Alchemie et les Alchimistes*, pp. 106, 107. For careful appreciation of Becher's position in the history of chemistry, see Kopp, *Ansichten über die Aufgabe der Chemie*, etc., von Geber bis Stahl, Braunschweig, 1875, pp. 201 *et seq.* For the text proving the existence of the philosopher's stone from the book of Revelation, see Figuiet, p. 22.

entific proofs, accepts the interference of the devil in physical phenomena as in other directions, and applies the mediæval theological method throughout his whole work.*

Yet far more remarkable was the example, a century later, of the man who more than any other led the modern world out of the path opened by Aquinas, and into that which Roger Bacon had sought to open and which has led modern thought to its greatest conquests. Strange as it may at first seem, Francis Bacon, whose keenness of sight revealed the delusions of the old path and the promises of the new, and whose boldness did so much to turn the world from the old path into the new, presents in his own writings one of the most striking examples of the evil he did so much to destroy.

The *Novum Organon*, considering the time when it came from his pen, is doubtless one of the greatest exhibitions of genius in the history of human thought. It showed the modern world the way out of the scholastic method and reverence for dogma into the experimental method and reverence for fact. In it occur many passages which show that the great philosopher was fully alive to the danger both to religion and to science arising from their mixture. He declares that the "corruption of philosophy from superstition and theology introduced the greatest amount of evil both into whole systems of philosophy and into their parts." He denounces those who "have endeavored to found a natural philosophy on the books of Genesis and Job and other sacred Scriptures, so 'seeking the dead among the living.'" He speaks of the result as "an unwholesome mixture of things, human and divine; not merely fantastic philosophy, but heretical religion." He refers to the opposition of the fathers to the doctrine of the rotundity of the earth, and says that "thanks to some of them, you may find the approach to any kind of philosophy, however improved, entirely closed up." He charges that some of these divines are "afraid lest perhaps a deeper inquiry into Nature should penetrate beyond the allowed limits of sobriety"; and finally speaks of theologians as sometimes craftily conjecturing that if science be little understood, "each single thing can be referred more easily to the hand and rod of God," and says, "*This is nothing more nor less than wishing to please God by a lie.*"

No man who has reflected much upon the annals of his race can, without a feeling of awe, come into the presence of such clearness of insight and boldness of utterance, and the first thought of the reader is, that of all men Francis Bacon is the

* For Melancthon's ideas on physics, see his *Initia Doctrinæ Physicæ*, Wittenberg, 1557, especially pp. 243 and 274; also in vol. xiii of Bretschneider's edition of the collected works, and especially pp. 339-343.

most free from the unfortunate bias he condemns; that he, certainly, can not be deluded into the old path. But as we go on through his main work we are surprised to find that the strong arm of Aquinas has been stretched over the intervening ages, and has laid hold upon this master-thinker of the seventeenth century. For only a few chapters beyond those containing the citations already made we find Bacon alluding to the recent voyage of Columbus, and speaking of the prophecy of Daniel regarding the latter days, that "many shall run to and fro and knowledge be increased," as clearly signifying "that . . . the circumnavigation of the world and the increase of science should happen in the same age."*

In his great work on the Advancement of Learning the firm grasp which the methods he condemned held upon him is shown yet more clearly. In the first book of it he asserts "that excellent book of Job, if it be revolved with diligence, will be found pregnant and swelling with natural philosophy," and he endeavors to show that in it the "roundness of the earth," the "fixing of the stars, ever standing at equal distances," the "depression of the southern pole," the "matter of generation," and "matter of minerals" are "with great elegance noted." But, curiously enough, he uses to support some of these truths the very texts which the fathers of the Church used to destroy them, and those for which he finds Scripture warrant most clearly are such as science has since disproved. So, too, he says that Solomon was enabled in his Proverbs, "by donation of God, to compile a natural history of all verdure."†

We have now seen how powerless were the strongest men in physical science, singly, in this struggle against theology and ecclesiasticism, and it may be well to study briefly their efforts after they had learned to combine in societies and academies against the common enemy. In the latter half of the sixteenth century, John Baptist Porta began his investigations, and despite much absurdity they were fruitful. His was not "black magic," claiming the aid of Satan, but "white magic" bringing into service the laws of Nature—the precursor of applied science. His

* See the *Novum Organon*, translated by the Rev. G. W. Kitchin, Oxford, 1855, chaps. lxxv and lxxxix.

† See Bacon, *Advancement of Learning*, edited by W. Aldis Wright, London, 1873, pp. 47, 48. Certainly no more striking examples of the strength of the evil which he had all along been denouncing could be exhibited than these in his own writings. Nothing better illustrates the sway of the mediæval theology, or better explains his blindness to the discoveries of Copernicus and to the experiments of Gilbert. For a very contemptuous statement of Lord Bacon's claim to his position as a philosopher, see Lange, *Geschichte des Materialismus*, Leipsic, 1874, vol. i, p. 219. For a more just statement, see Brewster, *Life of Sir Isaac Newton*. See, also Jevons, *Principles of Science*, London, 1874, vol. ii, p. 298.

book on Meteorology was the first in which sound ideas were broached on that subject; his researches in optics gave the world the camera obscura, and possibly the telescope; in chemistry he seems to have been the first to show how to reduce the metallic oxides, and thus to have laid the foundation of all those industries based upon the coloring and staining of glass and enamels; he did much to change natural philosophy from a "black art" to a vigorous open science. He encountered the old policy of conscientious men; the society founded by him for physical research, "I Secreti," was broken up, and he was summoned to Rome by Pope Paul III and forbidden to continue his investigations.

In 1624 some young chemists of Paris, having taught the experimental method and cut loose from Aristotle, the Faculty of Theology beset the Parliament of Paris, and the Parliament prohibited this new chemical teaching, under penalty of death.

The same war continued in Italy. In 1657 occurred the first sitting of the Accademia del Cimento at Florence, under the presidency of Prince Leopold dei Medici. This Academy promised great things for science; it was open to all talent; its only fundamental law was "the repudiation of any favorite system or sect of philosophy, and the obligation to investigate Nature by the pure light of experiment"; it entered into scientific investigations with energy. Borelli in mathematics, Redi in natural history, and many others pushed on the boundaries of knowledge. Heat, light, magnetism, electricity, projectiles, digestion, the incompressibility of water, were studied by the right method and with results that enriched the world.

The Academy was a fortress of science, and siege was soon laid to it. The votaries of scholastic learning denounced it as irreligious; quarrels were fomented; Leopold was bribed by a cardinal's hat and drawn away to Rome; and, after ten years of beleaguering, the fortress fell: Borelli was left a beggar; Oliva killed himself in despair.

So, too, the noted Academy of the Lincei at times incurred the ill-will of the papacy by the very fact that it included thoughtful investigators. It was "patronized" by Pope Urban VIII in such manner as to paralyze it, and it was afterward vexed by Pope Gregory XVI; even in our own time sessions of scientific associations were discouraged and thwarted by Pope Pius IX.*

* For Porta, see the English translation of his main summary, "Natural Magick," London, 1658. The first chapters are especially interesting, as showing what the word "magic" had come to mean in the mind of a man in whom mediæval and modern ideas were curiously mixed; see also Hoefer, *Histoire de la Chimie*, vol. ii, pp. 102-106; also Kopp; also Sprengel, *Histoire de la Médecine*, iii, p. 239; also Musset-Pathay. For the Accademia del Cimento, see Napier, *Florentine History*, vol. v, p. 485; Tiraboschi, *Storia della Letteratura*; Henri Martin, *Histoire de France*; Jevons, *Principles of Science*, vol. ii, pp. 36-40. For value

Such was the struggle of the physical sciences in general. Let us now look briefly at one special example out of many, which reveals, as well as any, the beginning, continuance, and end of theological interference with the evolution of them.

It will doubtless seem amazing to many that for ages the weight of theological thought in Christendom was thrown against the idea of the suffocating properties of certain gases, and especially of carbonic acid. Although in antiquity we see men forming a right theory of gases in mines, we find that, early in the history of the Church, St. Clement of Alexandria put forth the theory that these gases are manifestations of diabolic action, and that, throughout Christendom, suffocation in caverns, wells, and cellars was attributed to the direct action of evil spirits. Evidences of this view abound through the mediæval period, and even as late as the Reformation period a great authority, Agricola, one of the most earnest and truthful of investigators, still adheres to the belief that these gases in mines are manifestations of devils, and specifies two classes—one of malignant imps, who blow out the miners' lamps, and the other of friendly imps, who simply tease the workmen in various ways. He goes so far as to tell us that one of these spirits in the Saxon mine of Annaberg destroyed twelve workmen at once by the power of his breath.

At the end of the sixteenth century we find a writer on mineralogy complaining that the mines in France and Germany had been in large part abandoned on account of the "evil spirits of metals which had taken possession of them."

But at various periods glimpses of the truth had been gained. The ancient view had not been entirely forgotten; and as far back as the first part of the thirteenth century Albert the Great suggested a natural cause in the possibility of exhalations from minerals causing a "corruption of the air"; but he, as we have seen, was driven or dragged off into theological studies, and the world relapsed into the theological view.

Toward the end of the fifteenth century there came a great genius laden with important truths in chemistry, but for whom

attached to Borelli's investigations by Newton and Huygens, see Brewster's *Life of Sir Isaac Newton*, London, 1875, pp. 128, 129. Libri, in his *Essai sur Galilée*, p. 37, says that Oliva was summoned to Rome and so tortured by the Inquisition that, to escape further cruelty, he ended his life by throwing himself from a window. For interference by Pope Gregory XVI with the Academy of the Lincei, and with public instruction generally, see Carutti, *Storia della Accademia dei Lincei*, p. 126. Pius IX, with all his geniality, seems to have allowed his hostility to voluntary associations to carry him very far at times. For his answer to an application made through Lord Odo Russell regarding a society for the prevention of cruelty to animals and his answer that "such an association could not be sanctioned by the Holy See, being founded on a theological error, to wit, that Christians owed any duties to animals," see Frances Power Cobbe, *Hopes of the Human Race*, p. 207.

the world was not ready—Basil Valentine. His discoveries anticipated much that has brought fame and fortune to chemists since, yet so fearful of danger was he that his work was carefully concealed. Not until after his death was his treatise on alchemy found, and even then it was for a long time not known where and when he lived. The papal bull, *Spondent pariter*, and the various prohibitions it bred, forcing other alchemists to conceal their laboratories, led him to let himself be known during his life at Erfurt simply as an apothecary, and to wait until after his death to make a revelation of truth, which during his lifetime might have cost him dear. Among the legacies of this greatest of the alchemists was the doctrine that the air which asphyxiates workers in mines is similar to that which is produced by fermentation of malt, and a recommendation that in order to drive away the evil and to prevent serious accidents, fires be lighted and jets of steam used to ventilate the mines, laying stress especially upon the idea that the danger in the mines is produced by “exhalations of metals.”

Thanks to men like Valentine, this idea of the interference of Satan and his minions with the mining industry was gradually weakened, and the working of the deserted mines was resumed; yet, even at a comparatively recent period, we find it still lingering, and among leading divines in the very heart of Protestant Germany. In 1715 a cellar-digger having been stifled at Jena, the medical faculty of the university decided that the cause was not the direct action of the devil, but a deadly gas. Thereupon Prof. Loescher, of the University of Wittenberg, entered a solemn protest, declaring that the decision of the medical faculty was “only a proof of the lamentable license which has so taken possession of us, and which, if we are not earnestly on our guard, will finally turn away from us the blessing of God.”* But denunciations of this kind could not hold back the little army of science. In the last half of the eighteenth century Black, Priestley, and especially Bergmann, rooted out the very foundations of the whole theologic theory, and one more phantom which had long troubled the earth was at last driven forth forever.†

Thus, in spite of adverse influences, the evolution of the physical sciences went on. More and more there rose men bold enough to break away from the theological method, and strong enough to resist the enticements or threats of ecclesiasticism. Alchemy in

* For Loescher's protest, see Julian Schmidt, *Geschichte des geistigen Lebens*, etc., vol. i, p. 319.

† For the general view of noxious gases asimps of Satan, see Hoefer, *Histoire de la Chimie*, vol. i, p. 350, vol. ii, p. 48. For the work of Black, Priestley, Bergmann, and others, see main authorities already cited, and especially the admirable paper of Dr. R. G. Eccles on *The Evolution of Chemistry*, New York, D. Appleton & Co., 1891.

its first form, seeking for the philosopher's stone and the transmutation of metals, gave way to alchemy in its second form, seeking for the elixir of life and remedies more or less magical for disease; and this in turn yielded to the search for truth as truth. More and more the "solemnly constituted impostors" were resisted in every field. A great line of physicists and chemists began to appear. Though theological modes of reasoning continued to sterilize much effort in chemistry down to our own century, more and more the old influence was thrown off; more and more truth was sought as truth; less and less science was bent to aid in the alleged "saving of souls." "Black magic" with its satanic apparatus vanished, only reappearing occasionally among miracle-mongers and belated theologians. "White magic" became legerdemain.*

In our own time some attempt has been made to renew this war against the physical sciences. Joseph de Maistre, uttering his hatred of them, declaring that mankind has paid too dearly for them, asserting that they must be subjected to theology, likening them to fire—good when confined and dangerous when scattered about—has been one of the main leaders among those who can not relinquish the idea that our body of sacred literature should be kept a controlling text-book of science. The only effect of such teachings has been to weaken the legitimate hold of religion upon men.

In Catholic countries the effort has been of late years mainly confined to excluding science or diluting it in university teachings. Early in the present century a great effort was made by Ferdinand VII of Spain. He simply dismissed the scientific professors from the University of Salamanca, and until a recent period there has been general exclusion from Spanish universities of professors holding to the Newtonian physics. So, too, the contemporary Emperor of Austria attempted indirectly something of the same sort; and at a still later period Popes Gregory XVI and Pius IX discouraged, if they did not forbid, the meetings of scientific associations in Italy. In France, war between theology and science, which had long been smoldering, came in the years 1867 and 1868 to an outbreak. Toward the end of the last century, after the Church had held possession of advanced instruction for more than a thousand years, and had, so far as it was able, kept experimental science in servitude—after it had humiliated Buffon

* For a reappearance of the fundamental doctrine of black magic among theologians, see Rev. Dr. Jewett, Professor of Pastoral Theology in the Prot. Episc. Gen. Theolog. Seminary of New York, *Diabolology: The Person and Kingdom of Satan*, New York, 1889. For their reappearance among theosophists, see Elephas Levi, *Histoire de la Magie*, especially the final chapters.

in natural science, thrown its weight against Newton in the physical sciences, and wrecked Turgot's noble plans for a system of public instruction—the French nation decreed the establishment of the most thorough and complete system of higher instruction in science ever known. It was kept under lay control, and became one of the glories of France; but, emboldened by the restoration of the Bourbons in 1815, the Church began to undermine this hated system, and in 1868 had made such progress that all was ready for the final assault.

Foremost among the leaders of the besieging party was the Bishop of Orleans, Dupanloup, a man of many winning characteristics and of great oratorical power. In various ways, and especially in an open letter, he had fought the "materialism" of science at Paris, and especially were his attacks leveled at Profs. Vulpian and Sée, and the Minister of Public Instruction, Duruy, a man of great merit, whose only crime was devotion to the improvement of education, and to the promotion of the highest research in science.*

The main attack was made rather upon biological science than upon physics and chemistry, yet it was clear that all were involved together.

The first onslaught was made in the French Senate, and the storming party in that body was led by a venerable and conscientious prelate, Cardinal de Bonnechose, Archbishop of Rouen. It was charged by him and his party that the tendencies of the higher scientific teaching at Paris were fatal to religion and morality. Heavy missiles were hurled—such phrases as "sapping the foundations," etc., "breaking down the bulwarks," etc., and, withal, a new missile was used with much effect—the epithet "materialist."

The results can be easily guessed: crowds came to the lecture-rooms of the attacked professors, and the lecture-room of Prof. Sée, the chief offender, was crowded to suffocation.

A siege was begun in due form. A young physician was sent by the cardinal's party into the heterodox camp as a spy. Having heard one lecture of Prof. Sée, he returned with information that seemed to promise easy victory to the besieging party; he brought a terrible statement—one that seemed enough to overwhelm Sée, Vulpian, Duruy, and the whole hated system of public instruction in France—the statement that Sée had denied the existence of the human soul.

Good Cardinal Bonnechose seized the tremendous weapon. Rising in his place in the Senate, he launched a most eloquent invective against the Minister of State who could protect such a

* For Dupanloup, *Lettre à un Cardinal*, see the *Revue de Thérapeutique* of 1868, p. 221.

fortress of impiety as the College of Medicine; and, as a climax, he asserted, on the evidence of his spy fresh from Prof. Sée's lecture-room, that the professor had declared, in his lecture of the day before, that so long as he had the honor to hold his professorship he would combat the false idea of the existence of the soul. The weapon seemed resistless, and the wound fatal; but M. Duruy rose and asked to be heard.

His statement was simply that he held in his hand documentary proofs that Prof. Sée never made such a declaration. He held the notes used by Prof. Sée in his lecture. Prof. Sée, it appeared, belonged to a school in medical science which combated certain ideas regarding medicine as an *art*. The inflamed imagination of the cardinal's heresy-hunting emissary had, as the lecture notes proved, led him to mistake the word "*art*" for "*âme*" and to exhibit Prof. Sée as treating a theological when he was discussing a purely scientific question. Of the existence of the soul the professor had said nothing.

The forces of the enemy were immediately turned; they retreated in confusion, amid the laughter of all France; and a quiet, dignified statement as to the rights of scientific instructors by Wurtz, Dean of the Faculty, completed their discomfiture. Thus a well-meant attempt to check science simply ended in bringing ridicule on religion, and thrusting still deeper into the minds of thousands of men that most mistaken of all mistaken ideas—the conviction that religion and science are enemies.*

But justice forbids raising an outcry against Roman Catholicism alone for this. In 1864 a number of excellent men in England drew up a declaration to be signed by students in the natural sciences, expressing "sincere regret that researches into scientific truth are perverted by some in our time into occasion for casting doubt upon the truth and authenticity of the Holy Scriptures." Nine tenths of the leading scientific men of England refused to sign it; nor was this all: Sir John Herschel, Sir John Bowring, and Sir W. R. Hamilton administered, through the press, castigations which roused general indignation against the proposers of the circular, and Prof. De Morgan, by a parody, covered memorial and memorialists with ridicule. It was the old mistake, and the old result followed in the minds of multitudes of thoughtful young men.†

* For a general account of the Vulpian and Sée matter, see *Revue des Deux Mondes*, 31 mai, 1868; *Chronique de la Quinzaine*, pp. 763–765. As to the result on popular thought, may be noted the following comment on the affair by the *Revue*, which is as free as possible from anything like rabid anti-ecclesiastical ideas: "Elle a été vraiment curieuse, instructive, assez triste et même un peu amusante." For Wurtz's statement, see *Revue de Thérapeutique* for 1868, p. 303.

† De Morgan, *Paradoxes*, pp. 421–428; also, Daubeny's *Essays*.

And in yet another Protestant country this same mistake was made. In 1868 several excellent churchmen in Prussia thought it their duty to meet for the denunciation of "science falsely so called." Two results followed: upon the great majority of these really self-sacrificing men—whose first utterances showed complete ignorance of the theories they attacked—there came quiet and wide-spread contempt; upon Pastor Knak, who stood forth and proclaimed views of the universe which he thought scriptural, but which most school-boys knew to be childish, came a burst of good-natured derision from every quarter of the German nation.*

Warfare of this sort against science seems petty indeed; but it is to be guarded against in Protestant countries not less than in Catholic; it breaks out in America not less than in Europe. Do conscientious Roman bishops in France labor to keep all advanced scientific instruction under their own control—in their own universities and colleges; so do many not less conscientious Protestant clergymen in our own country insist that advanced education in science and literature shall be kept under control in their own sectarian universities and colleges, wretchedly one-sided in their development, and miserably inadequate in their equipment: did a leading Spanish university, until a recent period, exclude professors holding the Newtonian theory; so have many leading American colleges excluded professors holding the Darwinian theory: have Catholic colleges in Italy rejected excellent candidates for professorships on account of "unsafe" views regarding the immaculate conception; so have Protestant colleges in America frequently rejected excellent candidates on account of "unsafe" views regarding the apostolic succession, or the incarnation, or baptism, or the perseverance of the saints.

And how has all this system resulted? In the older nations, by natural reaction, these colleges, under strict ecclesiastical control, have sent forth the most bitter enemies the Christian Church has ever known—of whom Voltaire and Renan and Saint-Beuve are types; and there are many signs that the same causes are to produce the same results in our own country.

I might allude to other battle-fields in our own land and time. I might show how, twenty years ago, attempts to meet the want in a great American State of an institution providing higher scientific instruction, were met with loud outcries from many excellent men, who feared injury thereby to religion; and how in various other States, at various times since, the same feeling has been shown. Happily, leading men at the centers of Christian thought in many countries are now taking a larger and better

* See the Berlin newspapers for the summer of 1868, especially Kladderatsch.

view: but I again point to the recent driving out of the Darwinian professors from the American college at Beirut, under the direction of American Protestants, as an evidence that the old spirit still exists; no longer, indeed, seriously injurious to science, but deeply injurious to religion.*

* It is an interesting fact that one of the men thus driven out of the American college at Beirut, for supposed adhesion to the doctrines of Darwin, has since become one of the most influential editors at Cairo, carrying on a daily journal and two periodicals, and exercising a far greater and wider influence upon thought in the East than ever before. Whatever may be thought of the system of philosophy advocated by President McCosh at Princeton, every thinking man must honor him for the large way in which he, at least, broke away from the traditions of that center of thought; prevented, so far as he was able, persecution of scholars for holding to the Darwinian view; and paved the way for the highest researches in physical science in that university. For a most eloquent statement of the opposition of modern physical science to mediæval theological views, as shown in the case of Sir Isaac Newton, see Dr. Thomas Chalmers, cited in Gore, *Art of Scientific Discovery*, London, 1878, p. 247.





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