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The idea of scientific progress in Antiquity and in the Middle Ages

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Summary

The author reviews the development of the idea of scientific progress from Graeco-Roman antiquity to the Middle Ages and shows that from Xenophanes (6th century BC) on, the notion of progress can be found in the works of many authors, including physicians, throughout the centuries. Even if at first the concept was often rather inchoate and limited to what we would call technology, in the Middle Ages the notion of scientific progress in general and in medicine in particular became closer to the modern one.

Resume

L'auteur suit revolution du progres scientifique depuis l'Antiquite greco-romaine jusqu'au Moyen Age et montre ainsi que si on se refere a Xenophanes (6e siecle avant notre ere), des progres ont ete realises par de nombreux scientifiques, notamment dans ce que nous appellerions le domaine des technologies, meme si au debut, il y avait une certaine incoherence. Par la suite et au Moyen Age, le progres scientifique et 1'evolution de la medecine sont davantage a rapprocher de notre concept actuel de progres.

Progress, defined by the dictionary as "the action or process of advancing or improving by stages or degrees: gradual betterment," can potentially take place in all areas of human endeavor. Without entering into a discussion about progress in general,[1] we will point out that many would agree that, throughout history, progress has taken place in some fields (e.g., abolition of slavery), whereas in others, it has been absent (e.g., in art we see no improvement from Homer to Dante nor from Praxiteles to Michelangelo);[2] in still others, progress may be debatable (we leave the reader to decide if there has been progress, for example, in politics).[3] There is no question, however, that there has been progress in science, including medicine; in other words, the existence of scientific progress is undeniable.[4] By scientific progress we mean the improvement in our understanding of natural phenomena through the incremental accumulation of knowledge obtained by the scientific method and through the continuous elimination of error. The scientific method, as we have seen elsewhere,[5] can be defined as the collection of data through observation, the formulation of hypotheses, and the confirmation of the hypotheses by experimentation.

Although there is disagreement on the issue,[6] it would appear that the notion of gradual betterment in general and of progressive accumulation of knowledge in particular goes back to the early years of the Western Civilization. At the time, however, such a generalization (i.e., the idea of progress) could be perceived, as one would expect, only by few scholars who had a keen sense of the short history of the young civilization. This and the fact that, as we have noted above, in certain non-scientific fields progress may not be as evident have probably contributed to the uncertainty and differences among modern authors discussing the subject.

Among the ancient Greeks, the first author who seems to have had a notion of the accumulation of knowledge is Xenophanes (6th century BC). He wrote :

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At the beginning the gods revealed nothing to mankind. Little by little, however, men discovered improvements by research.[7]

Medical men entered the picture quite soon and, in Hippocratic times, the author of *On Ancient Medicine* (5th-4th century BC) stated :

Many great medical discoveries have been made in the course of the centuries, and the rest will be discovered if competent men, familiar with past knowledge, take it as a basis for their research.[8]

I believe that we must ... admire how [in medicine] from profound ignorance [in the past] discoveries have been made, not by chance, but by good and learned research.[9]

In another Hippocratic writing, *On the Art* (5th-4th century BC), the author affirmed :

To make new and useful discoveries of a useful kind, or to perfect what was incomplete, is the ambition and goal of intelligence.[10]

The two greatest philosophers of antiquity, Plato (c.427-347 BC) and Aristotle (384-322 BC), in different ways, both saw the development of knowledge in the light of a pre-existing model or form.[11] Aristotle, however, realized that there was improvement in some fields :

Such changes in ... arts and sciences have certainly been beneficial; medicine, for example, and gymnastics, and every other art and craft have departed from traditional usage.[12]

And :

It is true indeed that these and many other things have been invented several times over in the course of ages, or rather times without number; for necessity may be supposed to have taught men the inventions which were absolutely required, and when these were provided, it was natural that other things which would adorn and enrich life should grow up by degrees.[13]

The above quotes indicate that the Stagirite had a notion of change and improvement although, perhaps, not of progress in the sense defined above. In fact, it has been suggested that, for Aristotle, "the advances made by the arts and sciences in each civilization were the fulfillment of the potentialities of their natural form beyond which they could not go."[14] As for Plato, in spite of the claim of some that he was a supporter of the idea of progress,[15] his concept of it consists in the approximation to a pre-existing model, the eternal and unchanging model in the world of transcendent Forms.[16]

In the Hellenistic Age, some scientists were clearly conscious of progress. Thus Archimedes (c.287-212 BC) wrote that, by using his method,

... some either of my contemporaries or of my successors will be enabled to discover other theorems in addition, which have not as yet occurred to me.[17]

Philo of Byzantium (c.220 BC),[18] wrote that Alexandrian engineers improved on war machines

... partly by learning from the earlier constructors, partly by observation of later trials.[19]

The astronomer Hipparchus (2nd century BC) compiled a list of all the fixed stars known to him in order that later astronomers might be able to compare his observations with their own and thus determine what changes, if any, had occurred in the population of the heavens.[20] Polybius (c. 200-118 BC) noted continuous advances in technology, at least up to his time :

In offering these observations I am acting up to the promise I originally made at the outset of this work. For I stated that in our time all arts and sciences have so much advanced that knowledge of most of them may be said to have been reduced to a system. This is, then, one of the most useful parts of a history properly written.[21]

Among Roman authors, the philosopher of science, Lucretius (c.99-55 BC), seemed to believe that civilization had reached its perfection.[22] On the other hand, Vitruvius (1st century BC) described the progress of architecture through the ages up to his time,[23] and Manilius (early 1st century AD) says :

Man's capacity for learning has by effort vanquished every difficulty, and did not count its task finished until reason had scaled the heavens and grasped the deep nature of things and seen in its causes all that exists.[24]

Pliny (23-79 AD), discussing astronomy, stated :

Nobody must abandon the hope that the generations are constantly making progress.[25]

Seneca (c.5 BC- 65 AD) clearly expressed the concept of a progressive increase in *sapientia* ("wisdom") :

I revere the discoveries of wisdom and their discoverers; it is great to inherit from so many. It is for me that they accumulated such bounty it is for me that they toiled. We must behave like a good head of the household, we must add to what we have inherited. Let this inheritance be increased when it passes from me to my descendants. Much remains to do and much will always remain so that he who shall be born a thousand centuries from now will not lack the possibility to add something... Our predecessors have done much but they did not complete the task.[26]

As Seneca uses *sapientia* ("wisdom" or "understanding") instead *ofscientia* ("knowledge"), he may not mean progress in knowledge but in the wisdom needed for the application of knowledge itself. In fact he may even have believed that the ancients had already discovered all that there was to discover. In the same *epistula* he says :

But even if the ancients had discovered everything, one thing will be always new, the application of the discoveries already made and their interpretation.[27]

On the other hand, it could also be that he used the expression "even if the ancients had discovered everything" in the sense "but even if we were to assume that the ancients had discovered everything" to indicate that, even in this unlikely case, progressive accumulation of *sapientia* would occur. In *Naturales quaestiones,* he says :

The time will come when careful research over very long periods will bring to light things which now lie hidden ... this knowledge will be unfolded only through successive ages. There will come a time when our descendants will be amazed that we did not know things that are so plain to them.[28]

And

Many things that are unknown to us the people of the coming age will know. Many discoveries are reserved forages still to come ... Nature does not reveal her mysteries once and for all... This age will glimpse one of the secrets; the age which comes after us will glimpse another.[29]

It would appear, therefore, that in both Greek and Roman antiquity several authors had a notion of progress, even if rather inchoate in some cases and limited to what we would call technology.[30]

A concept of progress closer to the modern arose in the Middle Ages. In this discussion we will limit ourselves to the idea of progress in the knowledge and understanding of nature, that is, in science in general and in medicine in particular (in other words, scientific progress), and we will not take into consideration the progress in ethics and theology, considered implicit at the time, resulting from the Christian and Islamic revelations.[31]

The origin of the concept of scientific progress in the Middle Ages is associated with a famous expression, which is often wrongly attributed to Newton. In a letter to Robert Hooke, in fact, Newton (1642-1727) wrote: "If I have seen farther it is by standing on the shoulder of giants."[32] This figure of speech, often also considered the expression of the concept of scientific progress characteristic of the Scientific Revolution, did not, however, originate with Newton. Diego de Estella (1524-1578), the Spanish exegete, mentions it in his *In sacrosantum evangelium Lucae enarratio,* as Robert Burton (1577-1640), in the introduction ("Democritus to the Reader") of his *Anatomy of Melancholy* (1621), reports :

Though there were many giants of old in Physic and Philosophy, yet I say with Didacus Stella,[33] *"A dwarf standing on the shoulders of a giant may see farther than a giant himself...*[m]

Newton possibly obtained the expression from Burton. On the other hand, neither was Diego de Estella the originator of the dictum, which, as reported by John of Salisbury,[35] can be traced back to Bernard de Chartres (d. 1126):

Bernard of Chartres used to say that we are like dwarfs sitting on the shoulders of giants.

For this reason we can see more and farther away, certainly not because of the acuity of our sight or the height of our body but because we have been brought up and elevated by the size of the giants.[36]

It is of interest that what appears to some to be the first unambiguous statement about progress[37] was made by a grammarian, that is, by somebody for whom the interest in science was not central. For this reason, it has been suggested that the *nani gigantum humeris insidentes* of Bernard de Chartres concerns only grammar and is not an assertion of the belief in the progressive acquisition of knowledge in general, that is, of progress.[38] In fact, the image was used in relation to grammar in the first redaction of the glosses of Priscianus by William of Conches[39] (a disciple of Bernard de Chartres and also teacher at Chartres, as noted above[40]),[41] who affirmed that *sumus relatores et expositores veterum, non inventores novorum.*[42]

The possibility that Bernard de Chartres did not use the image to indicate progress of knowledge in general cannot be eliminated (we have no writings of Bernard de Chartres and we must rely on the writings of his contemporaries); nevertheless, his *nani gigantum humeris insidentes* has been quoted again and again by many through the centuries in the course of discussions about progress.[43]

After Bernard de Chartres, however, others, for whom also the primary interest was not science, perceived the dynamic, progressive, process of acquisition of knowledge. Gilbert of Tournay (fl. c.1250), an educator and a moralist, wrote :

Never will we find truth if we content ourselves with what is already known ... Those things that have been written before us are not laws but guides. The truth is open to all, for it is not yet totally possessed.[44]

In 1306 Fra' Giordano da Pisa, a Dominican, in a sermon given at Santa Maria Novella in Florence, said :

Not all the arts[45] *have been discovered. We will never see the end of discovering new ones. Every day a new one could be found ... new arts are, in fact, continuously found. It is not twenty years that was discovered the art of making spectacles, which make one see well. This is one of the best and most necessary arts that the world has seen. And it is such a short time that a new art that never existed before was discovered ...I myself saw the man who discovered it and made it, and I talked to him.*[46]

As for scholars whose interest was more focused on science, Judah ben Salomon al-Harizi, a Hispano-Jewish poet philosopher and physician (fl. first half of the thirteenth century), concerning the movements of celestial bodies, said :

At the present time this is not completely known, but when we will have a complete knowledge of these things, we will know the number of celestial movements.[47]

Roger Bacon (c. 1214-c. 1294) had a clear concept of the process of growth of knowledge and understanding :

[Seneca] says that nothing is perfect in human findings /inventionibusy *and states that the moderns know more than their predecessors because they engage later in the same efforts. We must study closely the ideas of the ancients so that we can add what they did not know and correct what they got wrong ... and increase our understanding and accumulation of wisdom; in this life understanding can grow because nothing is perfect in human findings.*[48]

And :

The study of wisdom can always increase in this life, because nothing is perfect in human discoveries. Hence we of a later age should supply what the ancient lacked, because we have entered into their labours, by which, unless we are asses, we can be aroused to better things; since it is wretched to be always using and never making discoveries.[49]

Concerning the idea of progress in the healing arts, we have seen in Volume IV of our History of Medicine[50] that in the Byzantine period medicine was often considered an *arsperfecta,* that is, completed, perfected; in other words, it was believed that the ancients had discovered everything that there was to discover in the field and that the function of physicians of later times was to study and elaborate their findings. Some authors believe that

the same perception of medicine prevailed in the Latin Middle Ages as well.[51] This does not seem to be the case. The following quotes indicate that many among the leading physicians of the time had a clear understanding of the incremental nature of medical knowledge, that is to say, they realized that medicine was an *ars imperfecta*.

Henry de Mondeville (c.1270-c.1325), enumerating the reasons for writing his *Antidotahus,* that is, Treatise V of his *Cyrurgia,* wrote :

There are seven reasons for the composition of this antidotary. 1) Every day there are new surgical cases for which it is necessary to apply new medications and new situations require new solutions. 2) Even if no new cases were to present themselves, for common cases known since antiquity new ways to proceed have been discovered, which necessitate new local treatments. 3) Even if no new cases were to present themselves and no new local treatments were to be used, it is possible that new virtues of ancient treatments may have been discovered by modern experience and these cannot be ignored .. .[52]

It is evident that even if the concept of progress is not explicitly stated in this passage, the author expresses a dynamic notion of surgery that is incompatible with the idea of *ars perfecta.* The concept of progress is more clearly stated in the passage that follows, in which the figure of speech of a dwarf on the shoulder of a giant is used :

... 6) It seems absurd and almost heretical to believe that sublime and glorious God would have given Galen a great mind with the condition that nobody after him would be able to discover anything new; in so doing, he would have limited his own power. Did not God give all of us a natural talent as he gave to Galen? Our talent however would be miserable indeed if we could know only what has been already discovered. In fact, the moderns are, in respect to the ancients, like a dwarf on the shoulder of a giant, who can see what the giant sees and more; for this reason, we know things that were not known at the time of Galen, and it is necessary to put them in writing. 7) If the [old] treatment of a certain subject seems deficient, and is deficient, more should be said about it; we see this also in the mechanical arts, for example in architecture: if somebody who was excellent in building temples and palaces at the time of Galen were to come back from the dead, he would not be suitable to be even an assistant of a builder of our days. In addition, we see that ancient palaces and temples are destroyed to be better re-built; in the same way, in fact with more reason, in the liberal sciences ancient notions can be corrected and others are to be added and the new ones described in writing ...[53]

It is difficult to deny, we believe, that the above quote indicates a very clear perception on the part of Henry de Mondeville of the concept of progress. In addition, such a concept is reiterated in the following passages from his *Cyrurgia* :

As in human affairs nothing is perfect /perfectumy,[54] *often those who come later, even if not as great, can correct, improve and complete the excellent contributions of their predecessors by adding what is new found by practice and experience. In fact, the same question that somebody [i.e., some scholar] settles one day, is settled and arranged in a different way next day (or even immediately), by the same person or by somebody else. These scholars deserve commendations and thanks because by so doing they stimulate the intellect of others to do better so that they may do work that, as much as possible, is error-free and perfect ...*[55]

Again, the dynamic perception of the acquisition of knowledge is evident. Other passages underline the same idea :

... many new cases present themselves everyday, in addition our predecessors... failed to report many data important for this art [i. e., surgery], either because very important notions had not yet been completely elucidated in their time, or because they did not know all that had been discovered, or because they did not want to reveal everything that they knew, or because books cannot contain everything necessary or, if they could, their length would cause tedium and disdain.[58]

...the surgeon must not rely too much on what

is written in books but, before he operates according to information found there, he should evaluate and appraise it in the light of his judgment ... [because] particulars are and will always be infinite in number and therefore unknown ... therefore it is the right of anybody who practices according to his knowledge to add and subtract to the rules of the ancients as he sees fit. Nor must any author be [blindly] followed because his rules are valid in many cases because in human affairs nothing is perfect and the successors ... can correct and improve by adding the new that they found by practice and experience.[57]

At the risk of appearing monotonous, we have listed all the above passages from Henry de Mondeville because, in an attempt to deny that in the Middle Ages progress was recognized, efforts have been made to explain the words of de Mondeville in a different way, even if with arguments that appear cloudy and uncertain.[58]

Other medieval practitioners of medicine recognized that progress was being made in their field both in the West and among Islamic physicians in spite of the assertion by some that the idea of progress was absent among Islamic authors,[59] while present in Western science.[60]

Guy de Chauliac again uses the expression of the shoulder of a giant and says :

We are like children on the shoulder of a giant: we can see all that the giant sees and more in addition[61]

and, as we have shown in Volume IV of our History of Medicine,[62] several Islamic authors had a clear idea of the concept. We will again quote here the pertinent passages.

In a discussion between Rhazes (865—925) and Abu Hatim, a philosopher, when Rhazes asserts that he has established a fact that contradicts the assertions of the ancients, Abu Hatim says :

Are they [i.e., the ancients] not your guides? Have you not followed them, you who has learned from their books, studied they writings and examined the foundations of their knowledge? How can he who comes after be superior to the one whom he follows and he who is guided have more wisdom than he who guides him?

And Rhazes answers :

Every philosopher who follows the Ancients, if he has dedicated his energy to philosophy... acquires and absorbs the knowledge of those who have preceded him. But, with his intelligence, he will understand other things and surpass [the ancients] because research, observation, and constant effort, by necessity, result in addition to knowledge.[63]

And, in *Dubitationes in Galenum,* Rhazes says :

...the sciences develop continuously with the passage of time, approaching more and more to perfection. This is why a man living in a later age ... will have a better chance of discovering more ... There is an analogy between ancients [scholars] and those who acquire [property] and between later scholars and heirs [of the property] to whom the fact in itself of inheriting it gives them a chance to add larger and larger acquisitions.[64]

Al-Asturlabi's (d. 1139-1140), in his *Kitab al-amal bi-l-kurah,* expressed similar views :

The ancients distinguished themselves through their chance discovery of basic principles and the invention of ideas. The modern scholars, on the other hand, distinguish themselves through the invention of a multitude of scientific details, the simplification of difficult (problems), the combination of scattered (information), and the explanation of (material which already exists in) coherent (form). The ancients came to their particular achievements by virtue of their priority in time, and not on account of any natural qualification and intelligence. Yet, how many things escaped them which then became the original inventions of modern scholars, and how much did the former leave for the latter to do! [In the maqamah *which] he called* al-Maraghiyah, *the learned religious leader Abu Muhammad al-Hariri expressed himself very well on the subject of the greater excellence of the ancients as compared with modern men. He said:*

...do the ancients have anything else but well-worn and limited ideas which are transmitted in their name, just because they happen

to *have been born at an earlier date, and not because of some (kind of natural) precedence such as the person who returns from the watering place possesses over the person who goes down to it.*[65]

As-Samawal (fl. c. 1150) in *Kitab kashfawar al-unajjimin wa-ghalatihim fl akthar al-amal wa-l-ahkam* ("The Exposure of the Faults of the Astrologers and their Errors in Most Operations and Judgments") states :

... most... assume that the ancients discovered all the knowledge that can be known; that nobody is able to know what they did not know; and that which they did not know cannot be known, nor can that which they did not understand be understood by anybody else. Many of them, therefore, refuse to listen when they hear that we corrected a number of the most learned former scholars. Their very nature recoils from such an idea. They cannot bring it over their lips. Their attitude may be explained either by the assumption that all intellectual knowledge which can be attained has reached its limits with the (ancients), that the intellect will produce no new combinations - this is against the nature of intellectual knowledge - or their attitude may be explained by a belief on their part that the ancients possessed infallibility and a power of mind the like of which no later person can have. Now, the only human beings who possess infallibility are the prophets. Unless an excessive bias and a fondness for strange opinions cause those people to equate knowledge with prophetical inspiration, the facts will force them to admit that in every age, knowledge manifests itself in an increasing volume and with greater clarity. The biographies of scientists bear witness to this fact. Euclid collected the geometrical figures which were widely known in his time in a systematic work on the principles of geometry. He perfected the work by his own additions of instructive figures. The statement that before the time of Euclid, there existed no geometer or outstanding brain at all is contradicted by the testimony of history. On the other hand, the contention that Euclid knew more about geometry than the many excellent scholars who lived before his time does not necessarily imply that Euclid might not be succeeded by someone who, as Euclid was better than his predecessors, would be better than Euclid. There is, for instance, Archimedes. His book on the Sphere and the Prism *entitles him to such a rank (of superiority over Euclid). In his* Lemmata, *Archimedes now had to admit his inability to achieve the bisection of angles. After Archimedes, Apollonius earned greater fame than anyone else, in particular, through his discovery of the properties of conic sections. No further progress was achieved (for a long time). Eventually, however, the measuring of the parabola was discussed by Ibrahim ibn Sinan ibn Thabit ibn Qurrah [d. 946]; the bisection of angles by Abu Jafar al-Khazin as Saghani [d. 961-971]; and the construction of the heptagon in the circle by Wayjan ibn Rustam al-Kuhni [second half of tenth century]. The division of numbers by a number of numerical quantities and the theory of roots of numbers in which there occur minus signs, as well as the demonstration of the arithmetical axioms of Pythagoras - all that, with proofs added, was discussed by me in the* Kitab al-bahir. *There still remain the division of angles into five equal parts; the construction of regular polygons of eleven, thirteen, and seventeen sides in the circle; all cases of trinomial cubic equations, quadrinomial equations, as well as higher polynomial equations; and other problems. Those problems are as yet unsolved, but it can be proven that a solution exists and is not impossible. The fact that their solution has been impossible for us and all our predecessors merely shows that the knowledge at hand and the available postulates are not sufficient to discover the solution and that other still unknown postulates are needed. It is not impossible that we will be succeeded by someone to whom God will show the solution. He may find it through other postulates of his own discovery. Or he may be led to the solution from the known postulates from which no one else had so far been able to reach it. No sage or well-informed historian will deny the fact that all the various disciplines of knowledge have manifested themselves in a process of gradual increase and ramification. The process stops at no final point and tolerates no irregularities ... Every intelli-*

gent person knows that the fact that someone is able to correct former scholars does not imply that that same man possesses a greater knowledge than they in all their branches of knowledge. It merely implies that he has farther progressed than they in the knowledge of just that particular matter.[66]

The evidence indicates that not only did some Islamic authors have a clear notion of scientific progress but that Rhazes expressed it plainly before any medieval author of the Latin West.

In conclusion, although a more or less inchoate concept of scientific progress arose in antiquity, a clearer idea, progressively closer to our modern understanding of the notion, evolved in the Middle Ages, even if, initially, it was shared only by few. That most authors at first did not recognize the existence of progress is to be expected because, among other reasons, of the religious climate prevalent at the time. A theological approach to knowledge tends, in fact, to contradict the idea of progress. If God has decided to let us know only what is written in the sacred scriptures, other knowledge is vain and superfluous. This approach operated in the Islamic and Christian Medieval tradition and explains the attitude of fundamentalist Islamic authors (see, for example, Prophetic Medicine)[67] and Christian authors like Vincent de Beauvais. We have seen, however, that, both in Islam and in the Latin West, authors could embrace the idea of progress without contradicting the tenets of the faith. As happens in the emergence of all new concepts, at the beginning only a few embrace it and, if valid, eventually the majority follows.

By the end of the Middle Ages, European intellectuals became increasingly aware of technological progress. Giovanni Tortelli, a humanist at the papal court, around 1450 wrote an essay proudly listing new inventions, and the artists of Burgundy "reaffirmed the thesis of the illuminator of the Utrecht Psalter" that an advancing technology is morally salutary. They clothed Temperance, who was by now the most important virtue, with the symbols of medieval inventiveness: on her head she wore a mechanical clock, in her right hand she held eyeglasses, and she stood on a tower windmill, which was the most impressive power machine of the time.[68]

As for the existence of progress, we want to underline that not only is scientific progress undeniable but, because of the evolution of the idea of it from antiquity to the Middle Ages, there has been progress even in the very concept of progress.

Notes and References

1 Somebody interested in exploring the deep philosophical waters of all aspects of the idea of progress can try: Charles Van Doren, *The Idea of Progress,* New York, Frederick A. Praeger, 1967.

2 In fact, some among us may even hold that between the *Divina Commedia* and contemporary poetry and between the *David* and contemporary sculpture there has been regress rather than progress.

3 There are other fields in which progress is brought about by the accumulation of knowledge not acquired by the scientific method. For example, thanks to the discovery of new manuscripts, more ancient works are available now than a few centuries ago; new discoveries of historical documents give us more information about historical events, etc.

4 We have seen elsewhere (P. Prioreschi, *A History of Medicine,* Volume I, *Primitive and Ancient Medicine,* Omaha, Horatius Press, 1996, Foreword; P. Prioreschi, *A History of Medicine,* Volume III, *Roman Medicine,* Omaha, Horatius Press, 1998, Foreword) that some contemporary authors, more or less influenced by the vacuities of post-modernism, have denied the existence of progress, even in science and especially in medicine. We still encounter authors, however, who do not seem to have lost their bearings. Concerning medicine, Getzsays: "Medical technology has made unbelievable progress and only a fool would wish it away" (Faye Getz, *Medicine in the English Middle Ages,* Princeton, Princeton University Press, 1998, p. 92).

5 P. Prioreschi, *A History of Medicine,* Volume I, *Primitive and Ancient Medicine,* Omaha, Horatius Press, 1996, Foreword, p. xxviii.

6 Walter Bagehot, in 1872, said: "The ancients had no conception of progress; they did not so much as reject the idea; they did not even entertain the idea," and his assertion has often been accepted since. On the other hand, a couple of years after Bagehot, Henry Maine stated that the Greeks "created the principle of Progress," and his assertion has also been accepted by several authors (Eric E. Dodds, *The Ancient Concept of Progress and other Essays on Greek Literature and Belief,* Ox-

ford, The Clarendon Press, 1973, p. 1). Zilsel believed that no idea of progress existed in antiquity (Edgar Zilsel, "The Genesis of the Concept of Scientific Progress", *Journal of the History of Ideas,* VI, 325-349, 1945; Edgar Zilsel, "The Genesis of the Concept of Scientific Progress," in: *Roots of Scientific Thought: A Cultural Perspective,* edited by Philip P. Wiener and Aaron Noland, New York, Basic Books, 1957, pp. 1251-1275). More recently, Crombie and Gimpel have also concluded that the idea of the general progress of knowledge *(scientia)* was not characteristic of the ancient world (A. C. Crombie, "Some Attitudes to Scientific Progress: Ancient, Medieval and Early Modern," *History of Science,* XIII, 213-230, 1975; Jean Gimpel, *The Medieval Machine: The Industrial Revolution of the Middle Ages,* New York, Holt, Rinehart and Winston, 1976, p. 147), whereas Edelstein has come to the opposite conclusion (Ludwig Edelstein, *The Idea of Progress in Classical Antiguity,* Baltimore, The Johns Hopkins Press, 1967, xi, xii ff.).

7 Xenophanes, frag. 18, in: Hermann Diels, Walther Kranz., *Die Fragmente der Vorsokratiker,* Zurich-Hildescheim, Weidmann, 1985 (reprint of the 1951 edition), 2 Vols., I, p. 133. See also: Eric E. Dodds, *The Ancient Concept of Progress and other Essays on Greek Literature and Belief,* Oxford, The Clarendon Press, 1973, p. 4.

8 *On Ancient Medicine,* Littre, I, p. 572.

9 *On Ancient Medicine,* Littre, I, p. 598.

10 *On the Art,* Littre, VI, p. 2.

11 Eric E. Dodds, *The Ancient Concept of Progress and other Essays on Greek Literature and Belief, Oxford,* The Clarendon Press, 1973, pp. 14-16.

12 Aristotle, *Politics,* II, 1268b, 33-36. Translated by B. Jowett in: *The Complete Works of Aristotle,* edited by Jonathan Barnes, Princeton, Princeton University Press, 1984, 2 Vols., II, p. 2013.

13 Aristotle, *Politics,* VII, 1329b, 25-30. Translated by B. Jowett in: *The Complete Works of Aristotle,* edited by Jonathan Barnes, Princeton, Princeton University Press, 1984, 2 Vols., II, p. 2110.

14 A. C. Crombie, "Some Attitudes to Scientific Progress: Ancient, Medieval and Early Modern," *History of Science,* XIII, 213-230, 1975.

15 This, for example, is Edelstein's opinion, which appears, however, to be one of his idiosyncrasies similar to the one concerning the HippocraticOath (see P. Prioreschi, *A History of Medicine,* Volume II, *Greek Medicine,* Omaha, Horatius Press, 1996, pp. 365-380). For a discussion of Edelstein's position on Plato as a supporter of progress, see Eric E. Dodds' review of Edelstein's *The Idea of Progress in Classical Antiquity,* in: *Journal of the History of Ideas,* XXIX, 453-457, 1968.

16 Eric E. Dodds, *The Ancient Concept of Progress and other Essays on Greek Literature and Belief,* Oxford, The Clarendon Press, 1973, pp. 14-16.

17 Archimedes, *Method,* p. 430 Heilberg. Quoted by Dodds in: Eric E. Dodds, *The Ancient Concept of Progress and other Essays on Greek Literature and Belief,* Oxford, The Clarendon Press, 1973, p. 18.

18 See: P. Prioreschi, *A History of Medicine,* Volume II, *Greek Medicine,* Omaha, Horatius Press, 1996, p. 154.

19 Philo of Byzantium, *Belopoika,* ed. Diels-Schram, p. 9. Quoted by Zilsel in: Edgar Zilsel, "The Genesis of the Concept of Scientific Progress," in: *Roots of Scientific Thought: A Cultural Perspective,* edited by Philip P. Wiener and Aaron Noland, New York, Basic Books, 1957, pp. 1251-1275.

20 Eric E. Dodds, *The Ancient Concept of Progress and other Essays on Greek Literature and Belief,* Oxford, The Clarendon Press, 1973, p. 18.

21 Polybius, X, 47,12-13. Translated by W. R. Paton, The Loeb Classical Library.

22 Lucretius, De *rerum natura,* V, 1456-1457.

23 Vitruvius, *De architectura,* II, i.

24 Manilius, *Astronomica,* I, 95 ff. Translated and quoted by Dodds in: Eric E. Dodds, *The Ancient Concept of Progress and other Essays on Greek Literature and Belief,* Oxford, The Clarendon Press, 1973, p. 23.

25 Pliny, *Natural History,* II, XIII, 62. Translation by H. Rackham, The Loeb Classical Library.

26 Seneca, *Ad Lucilium epistulae morales,* 64, vii, ix. Unless otherwise indicated, translations are by the author.

27 Seneca, *Ad Lucilium epistulae morales,* 64, viii.

28 Seneca, *Maturates quaestiones,* vii, 25, translated by T. H. Corcoran, The Loeb Classical Library.

29 Seneca, *Naturales quaestiones,* vii, 30, translated by T. H. Corcoran, The Loeb Classical Library.

30 Eric E. Dodds, *The Ancient Concept of Progress and other Essays on Greek Literature and Belief,* Oxford, The Clarendon Press, 1973, p. 25.

31 See: Alistair C. Crombie, "Alcuni atteggiamenti nei confronti del progresso scientifico: Antichita, Medioevo, inizi dell'Era moderna," in: *Ilconcetto di progresso nella scienza,* edited by: E. Agazzi, A. Borsellino et al., Milan, Feltrinelli, 1976, pp. 15-36.

32 L. T. More, *Isaac Newton,* New York, 1934, p. 176. Quoted by Sarton in: George Sarton, "Standing on the Shoulder of Giants," *Isis,* XXIV, 1, 107-109, 1935.

33 I.e., Diego de Estella.

34 Robert Burton, *The Anatomy of Melancholy,* London, William Tegg and Co., 1857, p. 8. See also: George Sarton, "Standing on the Shoulder of Giants," *Isis,* XXIV, 1, 107-109, 1935.

35 John of Salisbury did not attend the lectures of Bernard de Chartres. He probably learned of the expression from William of Conches, who was his

teacher (and disciple of Bernard de Chartres). Edouard Jeauneau, "'Nani gigantum humeris insidentes': Essai d'interpretation de Bernard de Chartres," *Vivarium,* V, 79-99, 1967.

36 John of Salisbury, *Metalogicon,* III, iv. Quoted by Sarton in: George Sarton, *Introduction to the History of Science,* Baltimore, William and Wilkins, Vol. II, Part 1,1931, p. 196. See also: John of Salisbury, *Metalogicon,* edited by Clement C. J. Webb, Oxford, Oxford University Press, 1929, p. 136. Quoted by: Gerhard B. Ladner, "Terms and Ideas of Renewal" in: Robert L. Benson and Giles Constable (Eds.), *Renaissance and Renewal in the Twelfth Century,* Cambridge, Harvard University Press, 1982, pp. 1-33, note No. 41. John of Salisbury himself stated "I have not disdained to cite the opinion of the moderns, which in many matters I do not hesitate to prefer to those of the ancients." John of Salisbury, *Metalogicon,* Prologus. Quoted by Jeauneau in: Edouard Jeauneau, "'Nani gigantum humeris insidentes': Essai d'interpretation de Bernard de Chartres," *Vivarium,* V, 79-99, 1967.

37 Raymond Klibansky, "Standing on the Shoulders of Giants," *Isis,* XXVI, 147-149, 1936.

38 See: Guy Beaujouan, "L'emergence medievale de l'idee du progres," *Bulletin de Philosophie Medieval,* XXX, 20-36, 1988; A. G. Molland, "Medieval Idea of Scientific Progress," *Journal of the History of Ideas,* XXXIX, 561-577, 1978; Edouard Jeauneau, "'Nani gigantum humeris insidentes': Essai d'interpretation de Bernard de Chartres," *Vivarium,* V, 79-99, 1967.

39 For William of Conches, see P. Prioreschi, *A History of Medicine,* Volume V, *Medieval Medicine,* Chapter IV, B (in preparation).

40 See note #35.

41 It is even possible that the reference of William of Conches to Bernard de Chartres' image may be anterior to that of John of Salisbury. See: Edouard Jeauneau, "'Nani gigantum humeris insidentes': Essai d'interpretation de Bernard de Chartres," *Vivarium,* V, 79-99, 1967.

42 "We are reporters and commentators of the ancients, not discoverers of new things." Quoted by Jeauneau in: Edouard Jeauneau, "'Nani gigantum humeris insidentes': Essai d'interpretation de Bernard de Chartres," *Vivarium,* V, 79-99, 1967.

43 For a review of old and new literature about the expression, see: Edouard Jeauneau, '"Nani gigantum humeris insidentes': Essai d'interpretation de Bernard de Chartres," *Vivarium,* V, 79-99,1967.

44 Quoted by Gimpel in: Jean Gimpel, *The Medieval Machine: The Industrial Revolution of the Middle Ages,* New York, Holt, Rinehart and Winston, 1976, p. 147.

45 By "arts" Fra' Giordano means what we would call "inventions" or "discoveries."

46 Quoted by White in: Lynn White, Jr., "Cultural Climates and Technological Advance in the Middle Ages," *Viator,* II, 171-201, 1971.

47 Vatican MS Heb. 338, fol. 130v. Quoted by Beaujouan in: Guy Beaujouan, "L'emergence medievale de l'idee du progres," *Bulletin de Philosophie Medieval,* XXX, 20-36, 1988.

48 Roger Bacon, *Opus majus,* ed. J. H. Bridges, I, 13, 20, 57. Quoted by Beaujouan in: Guy Beaujouan, "L'emergence medievale de l'idee du progres," *Bulletin de Philosophie Medieval,* XXX, 20-36, 1988.

49 Roger Bacon, *Opus Maius,* ii, 15, vol. iii, 69-70. Quoted by Crombie in: A. C. Crombie, "Some Attitudes to Scientific Progress: Ancient, Medieval and Early Modern," *History of Science,* XIII, 213-230, 1975.

50 P. Prioreschi, *A History of Medicine,* Volume IV, *Byzantine and Islamic Medicine,* Omaha, Horatius Press, 2001, pp. 73, 145, 165, 482.

51 Chiara Crisciani, "History, Novelty, and Progress in Scholastic Medicine," *Osiris,* VI, 118-139,1999. In this paper, Crisciani underlines that, in the Middle Ages, any change in medicine takes place "within a system that is presented as already substantially laid down, defined once and for all, closed. Medical knowledge is mobile, certainly, but in essentials not modifiable." In support, Crisciani mentions (footnote No. 37) works of Wear and Molland: Andrew Wear, "Galen in the Renaissance," in *Galen: Problems and Prospects,* edited by Vivian Nutton, London: Wellcome Institute for the History of Medicine, 1981, esp. pp. 241-244; and A. G. Molland, "Medieval Ideas of Scientific Progress," *Journal of the History of Ideas,* XXXIX, 561-577, 1978. Wear, discussing the views of Montanus, says: "Perhaps for the Renaissance an art was constituted from eternity or from its mythical moment of invention and was not 'discovered' and then taught but rather uncovered. The problem is that we do not possess the terminology to express what Montanus meant" (Andrew Wear, "Galen in the Renaissance," in *Galen: Problems and Prospects,* edited by Vivian Nutton, London: Wellcome Institute for the History of Medicine, 1981, p. 244). Molland says that, in general, "the very definite technical progress that was made during the Middle Ages very rarely gave rise to any generalized conception of progress that could, among other things, be extrapolated into the future" (A. G Molland, "Medieval Ideas of Scientific Progress" *Journal of the History of Ideas,* XXXIX, 561-577, 1978).

52 Henry de Mondeville, V *(Antidotarius),* I. *Die Chirurgie des Heinrich von Mondeville,* edited by Leopold Pagel, Berlin, Hirschwald, 1892, p. 507.

53 Henry de Mondeville, V *(Antidotarius),* I. *Die Chirurgie des Heinrich von Mondeville,* edited by

Leopold Pagel, Berlin, Hirschwald, 1892, p. 508.

54 The word *perfectum,* means not only "perfect," that is faultless, but "complete", "finished" as well, as in *ars perfects.*

55 Henry de Mondeville, *Cyrurgia,* Prooemium, *Die Chirurgie des Heinrich von Mondeville,* edited by Leopold Pagel, Berlin, Hirschwald, 1892, p. 11.

56 Henry de Mondeville, *Cyrurgia,* II, Prooemium, *Die Chirurgie des Heinrich von Mondeville,* edited by Leopold Pagel, Berlin, Hirschwald, 1892, p. 61.

57 Henry de Mondeville, *Cyrurgia,* II, Notabilia, *Die Chirurgie des Heinrich von Mondeville,* edited by Leopold Pagel, Berlin, Hirschwald, 1892, p. 69.

58 Crisciani, concerning these passages of de Mondeville, says: "But however suggestive these remarks may be, and certainly they permit us to recognize here a specifically cumulative meaning of progress, one ought not to forget the context in which Mondeville's really vehement innovative thrust was placed. In fact, alongside his enthusiasm for the "new," we find an equally obsessive demand for order, for the enclosure of the otherwise uncontrollable riches of innovation within the compactness of a rational and written system (which he himself intended to provide with his own text)." Chiara Crisciani, "History, Novelty, and Progress in Scholastic Medicine," *Osiris,* VI, 118-139, 1999. One cannot avoid astonishment when confronted with such preoccupation to dismiss evidence that seems quite clear.

59 Roshdi Rashed says: "It is in vain to look in the Arabic tradition - either philosophic or scientific - for an idea of progress ... The idea of a movement regulated at the same time by accumulation of knowledge and by a continuous elimination of errors ... is foreign to the Arab as well as to the other medieval tradition." Quoted by Beaujouan in: Guy Beaujouan, "L'emergence medievale de l'idee du progres," *Bulletin de Philosophie Medieval,* XXX, 20-36, 1988; Zilsel states: "[The idea of progress] is a specific characteristic of the scientific spirit of the modern Western civilization," and "The absence of slavery, the existence of machinery, the capitalistic spirit of enterprise and economic rationality seem to be prerequisites without which the ideal of scientific progress cannot unfold." Edgar Zilsel, "The Genesis of the Concept of Scientific Progress," in: *Roots of Scientific Thought: A Cultural Perspective,* edited by Philip P. Wiener and Aaron Noland, New York, Basic Books, 1957, pp. 1251-1275.

60 Beaujouan seems to concur with Richard Lemay that the idea of progress in the twelfth century concerns the advancement of science *chez les Latins.* Guy Beaujouan, "L'emergence medievale de l'idee du progres", *Bulletin de Philosophie Medieval,* XXX, 20-36, 1988.

61 Guy de Chauliac, *Chirurgia Magna,* Prooemium, in: Guigonis de Caulhiaco (Guy de Chauliac), *Inventarium sive Chirurgia Magna,* edited by Michael R. McVaugh, Leiden, Brill, 2 Vols., 1997,1, p. 1.

62 P. Prioreschi, *A History of Medicine,* Volume IV, *Byzantine and Islamic Medicine,* Omaha, Horatius Press, 2001, pp. 255; 472-473.

63 Abu Hatim, *Kitab a'lam an-nubawwa,* extracts edited by P. Kraus, "Raziana II," in *Orientalia N. S.* 5, 1936, pp. 44-45. Quoted by: Danielle Jacquartand Francoise Micheau, *La medecine arabe et /'Occident medieval,* Paris, Editions Maisonneuve etLarose, 1996, p. 61.

64 Quoted by Pines in: S. Pines, "Razi Critique de Galien," /Acres *du Vile Congres International d'Histoire des Sciences,* Jerusalem, 1953, pp. 480-487.

65 Al-Asturlabi, *Kitab al-amal bi-l-kurah.* Quoted by Rosenthal in: Franz Rosenthal, "Al-Asturlabi and as-Samawal on Scientific Progress," *Osiris,* IX, 555-564, 1950.

66 As-Samawal, *Kitab kashf awar al-unajjimin waghalatihim fl akthar al-amal wa-l-ahkam.* Quoted by Rosenthal in: Franz Rosenthal, "Al-Asturlabi and as-Samawal on Scientific Progress," *Osiris,* IX, 555-564, 1950.

67 P. Prioreschi, *A History of Medicine,* Volume IV, *Byzantine and Islamic Medicine,* Omaha, Horatius Press, 2001, pp. 352-360.

68 Lynn White, jr., "Cultural Climates and Technological Advances in the Middle Ages," *Viator,* II, 171-201, 1971.

Biography

Plinio Prioreschi, M.D., Ph.D., Professor of Pharmacology, Assistant Professor of Medicine, Member of the division of History of Medicine, Creighton University, Omaha, Nebraska, USA. Dr. Prioreschi is the author of over forty scientific publications in pharmacology and experimental medicine. Trained in internal medicine, he has practised medicine at university clinics and hospitals. For several years, he has been interested in the history of medicine and has published, in this field, papers, books, and book reviews; his books on history of medicine are: A History of Human Responses to Death *(New York, The Edwin Meilen Press, 1990); A History of Medicine, Vol. I,* Primitive and Ancient Medicine *(Second Ed., Omaha, Horatius Press, 1996); A History of Medicine, Vol. II,* Greek Medicine *(Second Ed., Omaha, Horatius Press, 1996); A History of Medicine, Vol. III,* Roman Medicine *(Omaha, Horatius Press, 1998); A History of Medicine, Vol. IV,* Byzantine and Islamic Medicine *(Omaha, Horatius Press, 2001). At present, Dr. Prioreschi is working on the fifth volume of his History of Medicine* (Medieval Medicine,). *His book* Man and War *(New York, Philosophical Library, 1987) is a historical work not related to medicine.*