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PAUL TANNERY AND THE *POUR L'HISTOIRE DE LA SCIENCE HELLÈNE. DE THALÈS À EMPÉDOCLE* (1887)

Paul Tannery's Pour l'histoire de la science hellène has had a profound impact on the understanding of the Presocratics by its interpretations of the individual authors, as well as its provocative general thesis according to which the Presocratics were primarily scientists and not philosophers. The paper starts with a brief overview of Tannery's unusual career and monumental œuvre. A chapter by chapter review of Pour l'histoire de la science hellène, focusing on Tannery's interpretative strategies and central explanatory concepts (infinity vs. finitude of the cosmos, daily revolution, the quest for Pythagorean influences, etc.), is followed by a discussion of Tannery's periodization, the influences of Comte, Diels, and Teichmüller, as well as the role Tannery assigns to Aristotle and the Pythagoreans.

Paul Tannery's *Pour l'histoire de la science hellène* was published eight years after Diels' *Doxographi Graeci* and was profoundly marked by it. Indeed, Tannery was among the first to fully recognize the importance of Diels' enterprise and to transfer Diels' methodology to the field of the history of mathematics. The real historical significance of Tannery's work, however, lies not so much in the propagation of Diels' results but rather in its central thesis, that Tannery announces in the Introduction and applies more or less consistently in the individual chapters of the book. According to this thesis the authors customarily called early Greek *philosophers* should be appreciated rather as *savants*, scientists, who were primarily concerned with the scientific description of the physical world. It is not that interpreters before Tannery had not recognized the importance of the physical views of these authors. Yet these physical, cosmological, astronomical views had largely been considered as one specific aspect of the *philosophical* doctrines of the early Greek *philosophers*; views that form their natural philosophy, which in turn is governed by their respective metaphysical views. Historians of philosophy, says Tannery, wish to reconstruct the systems of the individual early Greek thinkers on the basis of and starting from their assumed metaphysical doctrines. Tannery wants to reverse this perspective. He maintains that the scientific doctrines had cognitive priority for these Greek authors and should therefore be granted interpretative priority in their assessments; their philosophically significant ideas, or metaphysics, emerge only derivatively, if at all, when their scientific views lead them to even higher levels of abstraction. The

primary assessment of these authors is therefore the task of the history of science, and historians of philosophy should base their own interpretations on the judgements of historians of science.

Tannery formulates his general thesis briefly and somewhat crudely, and the application of the ensuing methodology is not always successful in the individual chapters of the book. *Pour l'histoire de la science hellène* is, in many respects, considerably less successful than Tannery's more specialized works on ancient mathematics and astronomy. Yet, Tannery's focus on the scientific aspects of the works of the Presocratics put into the foreground a number of specific questions that have remained central in all subsequent discussion. Even more importantly, the general programme of *Pour l'histoire de la science hellène*, or as Paul Natorp has put it in his review article of the book, its "revolutionary tendencies"¹ introduced into the study of the Presocratics a novel approach that has remained influential ever since.

We should, I think, add one more point already at the outset. Tannery was one of the first serious historians of science, who had a crucial role in the creation of history of science as an autonomous discipline.² As Helge Kragh wrote in his classic book *An Introduction to the Historiography of Science* (Kragh 1987, 15):³

"Paul Tannery (1843–1904) was probably the most important individual as far as the organization of the new history of science was concerned. Tannery, if anyone, is 'the true founder of the modern history of science movement'".

With Tannery, the new discipline not only discovered for itself the Presocratics as the first scientists, but also proclaimed that the study of the Presocratics belongs primarily to its sphere of competence and not to that of the history of philosophy. Tannery's work on the Presocratics is therefore important not only because of the modification of the image of the early Greek thinkers it introduced, but also because the Presocratics were instrumental in Tannery's efforts to emancipate the history of science from the history of philosophy.

After these preliminary remarks, and before turning to an analysis of the book, I shall first give a brief overview of Tannery's œuvre and professional career – remarkable in itself, but perhaps not familiar to historians of Greek philosophy.

I. A MONUMENTAL ŒUVRE AND AN UNUSUAL CAREER

When Paul Tannery died in 1904 at the age of 61 he left behind a prodigious and extraordinarily diverse œuvre. He published three monographs on ancient science. The first two, *Pour l'histoire de la science hellène. De Thalès à Empédocle* and *La géométrie grecque. Comment son histoire nous est parvenue et ce que nous en savons*, were both published in 1887. The latter was planned to be a multivolume work of which only the first volume, subtitled *Histoire générale de la géométrie*

1 Natorp 1889, 223.

2 This remains true even if he opted for joining the Congress of the History of Sciences in to the Congress of Philosophy in Geneva in 1904.

3 The quotation in Kragh's text comes from Guerlac 1963, 807.

élémentaire, was ever written. His third monograph, *Recherches sur l'histoire de l'astronomie ancienne*, came out sixteen years later.

The critical editions produced by Tannery are at least of equal importance. His edition of Diophantus for the Teubner series (1893–95) has been praised by his contemporaries and by his successors as a masterpiece that applies the highest philological standards to the edition of scientific works. As Johan Ludwig Heiberg, the editor of Euclid and Archimedes wrote (Tannery & al. 1938, 662): “This edition in itself would suffice to firmly establish [*sc.* Tannery’s] reputation as a first rate filologist”. But Tannery did not limit himself to antiquity. With Charles Henry, he made the first edition of the complete works of Pierre Fermat.⁴ More importantly, Tannery published with Charles Adam the critical edition of the works of Descartes in thirteen volumes – the famous ‘Adam-Tannery’ (1897–1913) which is still the principal reference edition of Descartes. Tannery died before the completion of the complete series. His main contribution was in the edition of the correspondence – which takes up the first five volumes – and in the scientific treatises in vol. VI and vol. IX. His extensive notes were, however, used by Charles Adam in the production of the remaining volumes as well.⁵

At the time of his sudden and early death Tannery was working on two further important editions, which were later finished and published on the instigation and with the active help of his widow, Marie Tannery (1856–1945). She was an outstandingly devoted, ambitious, yet humble woman, who entirely devoted herself to promoting the work of her husband while he was alive, and who made every possible effort to continue the work of her husband left unfinished at his death.⁶ With the editorial help of Cornélis de Waard and René Pintard, she finished the edition of the correspondence of Mersenne and encouraged Pelopidas Elpidios Stéphanou to complete the edition of Pachymeres’ *Quadrivium* (Vatican 1940), both undertaken but left unfinished by Tannery himself. Related to all these editions, completed, started, or only projected, Tannery wrote extensive philological, palaeographical, and historical studies.

The largest, and arguably most influential, part of Tannery’s output consists however not in his monographs and editions, but in his papers, articles, notices, and reviews on ancient, Byzantine, mediaeval, early modern and contemporary science and philosophy that he published in various journals and encyclopaedias.⁷ Indeed, it

4 The two editions are connected also by the fact that Fermat started to work on mathematics mostly on the inspiration of Diophantus’ *Arithmetica*.

5 For a detailed survey of the extent of Tannery’s contribution to each volume, see Adam 1905.

6 For a brief appreciation of the life and work of Marie Tannery, see Sarton 1947, 44–7. It ends with the sentences (*loc. cit.* 47): “Marie Tannery has given us the most remarkable example of conjugal piety in the whole history of learning. Her name will always be remembered by historians of science, together with that of her husband, Paul Tannery”. Tannery’s words in the Introduction of his *Histoire* on page v are also worth quoting: “... n’aurais-je jamais terminé ce volume ... si ... je n’avais été soutenu par l’appui dévoué, par les infatigables encouragements de celle qui est désormais la chère compagne de ma vie. Elle s’est sacrifiée à cette œuvre; c’est bien à elle que mon livre est dû, et je voudrais qu’il pût être plus complètement digne d’elle”.

7 Rivaud 1913, 178: “C’est dans ses articles, plus encore que dans ses livres de synthèse, que Paul Tannery a mis le meilleur de lui-même”.

is in these papers that one can especially appreciate Tannery's enormous erudition, meticulous method, historical sense and perspicacity in setting out problems and suggesting solutions. On the initiative and with the active contribution of Marie Tannery, the two Danish historians of mathematics, Johan Ludwig Heiberg (1854–1928) and Hieronymus Georg Zeuthen (1839–1920), collected most, but not all, of these writings and published them together with Tannery's extensive academic correspondence in sixteen volumes (plus vol. XVII containing bibliography and indexes) under the general title *Mémoires scientifiques* (1912–50).

The high quality and vastness of this œuvre is respectable enough in itself. What makes it, so to speak, larger than life is the fact that Tannery was not trained as a classicist, philosopher, or historian, and never had a regular academic job. All through his life he worked as an engineer and civil servant executive manager at various state tobacco factories in different parts of France. He produced his œuvre after the office hours he spent in the factories, between 8 pm and 1 am and on weekends. One can see also a touch of pride in his signature to the Preface to *Pour l'histoire de la science hellène*: “Paul Tannery, Directeur des Tabacs de Lot-et-Garonne”.

Although Tannery loved classical literature as a pupil at the lycées of Le Mans and Caen,⁸ he took the scientific specialisation and continued his studies at the prestigious École Polytechnique to become an engineer, following his father's profession. After the École Polytechnique, he completed his studies at the École d'application des Manufactures de l'État that qualified him to take up administrative positions in the industry. It is also during this period that Tannery studied closely the ‘*philosophie positive*’ of August Comte, the only philosophical work that left a lasting – but fortunately not too deep – mark on his work.⁹

Tannery started his professional career in Lille, where he worked as an assistant engineer for two years. From 1867 he served at the central tobacco administration in Paris, where he was enlisted as an artillery captain during the Franco-Prussian war. After the war he supervised the construction of several tobacco manufactures in Bergerac, St-Cyprien and Souillac. Having recovered from a serious illness, he directed the mechanization of the factory in Bordeaux. Although he much enjoyed the active intellectual life of the city, in 1877 he asked his transfer to Le Havre to be closer to his family. This is also in Le Havre that he met his future wife. Five years later he moved to Paris where he was an appraiser-engineer for three years. In 1886 Tannery became the director of the tobacco manufacture in Tonneins (Lot-et-Garonne, between Bordeaux and Cahors). Two years later, he was appointed director of the factory in Bordeaux where he spent another two years. In 1890 he was called back to Paris to organize the manufacture of matches. In 1893 he became the director of the tobacco factory in Pantin (now a north-east district of Paris) where he spent the last ten years of his life. The successive posts of his career indicate not only that he had a responsible professional life, involving numerous moves, but also that he had to live for years at places far away from any decent research library.

8 Delphin Tannery, Paul Tannery's father, was a railway engineer and the family had to move often because of his placements.

9 I shall shortly come back to the extent of Comte's influence.

It is during his two later stays in Paris that Tannery had the opportunity to teach. First, in 1884 and 1885 he had a free course at the Sorbonne on the history of mathematics that formed the basis of his monograph on the history of Greek geometry. Second, on his return to Paris in 1890 he was chosen by Charles Lévêque to substitute him at the chair of Greek and Latin Philosophy at the Collège de France, where Tannery then taught for five years – of course in his free time. After five years he had to renounce to this opportunity to consecrate more time and energy to the Descartes edition.

In 1903 came a great, but missed, opportunity to recognize Tannery's achievements. Since 1892 there had been a chair at the Collège de France for the History of Science, originally created for Pierre Laffitte, the disciple and successor of August Comte at the head of religious positivism. This chair was unique in Europe in so far as it was not a chair for the history of this or that science, but for the general history of science. When Laffitte died in 1903, the Assembly of the professors of the Collège de France decided to maintain the chair and the overwhelming majority of professors nominated Tannery as their first choice. This vote was then reinforced by the Académie des Sciences. As the choice of these two academic consultative bodies had never been overruled, everybody took Tannery's appointment a fact and he even started to work on his inaugural lecture. Yet the *Ministre de l'Instruction Publique* overruled the decision of the academic votes and appointed the second person on the list, Grégoire Wyruboff, a Russian born crystallographer, physico-chemist, and positivist philosopher of the Littré line. Wyruboff did not contribute to the history of science either before or after his appointment.¹⁰ This startling decision of the Ministry was apparently motivated by political and ideological reasons. The non-appointment of Tannery, who died a few months later, resulted in an international outrage and caused much damage to the history of science in France. The case has often been described and discussed as a paradigmatic example of the disastrous effects when politics and ideology interferes with science and compromises the professional autonomy of academic institutions.¹¹

After his unsuccessful attempt to become chair of the History of Science, Tannery tried again to become a professor at the Collège de France. When Henri Bergson was transferred to become professor of Modern Philosophy, the chair of Greek and Latin Philosophy became available. Tannery was a candidate for this post, and although the position clearly suited him much less, might very well have been elected, but he died just the day before the vote took place. On learning Tannery's death, the Assembly of the professors decided to cancel the chair.

Even though Tannery never fully became part of the academic institutions, he had a considerable role in the institutionalization of the history of science and in the general recognition of the history of science as an autonomous discipline. His vast correspondence with the leading figures of the international history of science scene shows his efforts to organize scientific meetings, the international cataloguing of source materials, publications and so forth. It is also worth mentioning that a month

10 For an overview and evaluation of Wyruboff, see Sarton 1947, 37–40.

11 See e. g. Paul 1976.

before his death the Société des Études Grecques appointed him president. Yet it seems that during his lifetime he remained much less influential in France than in other European countries or in the United States.¹² The *Pour l'histoire de la science hellène* was rediscovered in France due to its second edition, which was prepared by August Diès on the instigation of Mme. Tannery, and which appeared in 1930, more than forty years after its original publication.

II. *POUR L'HISTOIRE DE LA SCIENCE HELLÈNE*: ITS STRUCTURE AND CONTENT

1. *Conception and structure*

Tannery's post in Tonneins, away from the necessary resources for doing original research, created an opportunity for him to prepare some of his previous works for publication in book format. This is why he could publish his first two books almost simultaneously. Although I have referred to the *Pour l'histoire de la science hellène* as a monograph, the book is in fact based on a series of papers that Tannery wrote over a period of ten years and which, for the most part, had already been published in the *Revue Philosophique*. Tannery's Preface gives the impression that these papers were conceived already from the start as parts of a systematic treatment of the subject matter covered by the book. In Tonneins Tannery revised and enlarged these papers and, as he puts in the Preface, gave the book "a genuine organic unity" (*SH* 2nd ed. vi). These details about the book's conception may partly explain the impression that even though it has a clear overall message, and a roughly homogeneous methodology, the "organic unity" was not quite achieved. There is cohesion among some chapters, whereas some other chapters remain isolated and some explanatory concepts have a large share in some chapters but then completely disappear from the rest of the work with no obvious reason.

The structure of the book is as follows. First comes a 17 page long Introduction setting out the objectives and the plan of the book. Two further preparatory chapters follow, one on the doxographical tradition, and another on the chronology of the authors covered by the book. Tannery's procedure to start the discussion by a thorough examination of the nature of the sources is an indication of his high philological standards. The ensuing chapters deal with the individual thinkers, not according to their "schools", as it was more customary in the age, but in their chronological order as established in the second chapter: Thales, Anaximander, Xenophanes, Anaximenes (sic!), Heraclitus, Hippasos and Alcmeon, Parmenides, Zeno, Melissos, Anaxagoras, and finally Empedocles. At the end of each chapter Tannery provides a very generous selection of the doxographical material in French translation, based on the text of *Doxographi Graeci*, and then a French translation of the fragments of

12 In 1913 Rivaud could still write that: "L'histoire de la science, et particulièrement l'histoire de la science antique n'est guère cultivée en France, et c'est à l'étranger que Tannery a trouvé ses premiers disciples" (Rivaud 1913, 177).

the author treated in the chapter, on the basis of Mullach's *Fragmenta philosophorum graecorum* (Paris 1860). This documentary material attached to the individual chapters thus creates a comprehensive and systematic collection of the Presocratic fragments in French translation – the first of its sort, as far as I am aware. Two Appendices close the volume. The first of these offers a complete French translation of Theophrastus' *De Sensu* on the basis of Diels' text as published in *Doxographi Graeci*. The second, somewhat out of place, tries to reconstruct the arithmetic of the Pythagoreans in 22 pages.

In what follows, I shall first provide a review of Tannery's treatment of the individual authors, and then turn in the next section to a general assessment of the nature and aims of Tannery's work on the Presocratics.

2. *The discussion of individual authors*

i. Thales

Tannery starts his chapter with Zeller's characterization according to which Thales brought his scientific knowledge, in mathematics and astronomy, from the East, but his philosophical ideas were entirely his own inventions. For Tannery, the basic problem with this image is that it is based on preconceptions, and not on a detailed examination of the available, admittedly scanty, evidence. First we should determine the exact nature of the borrowings in the field of the mathematical sciences by the help of the most recent results of the Orientalist, such as Maspéro's *Histoire ancienne des peuples d'Orient* (Paris 1875). On this basis, we shall then be able to say something more specific not only about the nature of the borrowings in the other fields of science, but also in the field of philosophy. Tannery clearly uses his own interpretative principle according to which the philosophical ideas supervene on the scientific views.

Tannery's ultimate conclusion will be that both philosophy and science as such are the innovations of the Greeks. However, both manifest themselves not with Thales but with Anaximander. Thales' inclinations were practical and his journeys to Egypt were motivated by pragmatic reasons. He did not invent anything, but introduced into Greece some of the empirical data collected by the Egyptians and Persians and some technical skills and observational procedures used by them. It is also on this basis that he could predict the year in which an eclipse would occur. He may have learnt from the Egyptians the use of the gnomon and how to determine, at least approximately, the equinoxes and the solstices. He could also take home some basic elementary arithmetical and geometrical procedures, but these have nothing to do with mathematics proper. His conception of the universe is as follows. There is a hemispherical bubble of air in a great (infinite?) mass of air. On the flat side of the bubble floats the discoid earth, whereas the celestial gods travel in their barks sometimes on the hemisphere above the earth, sometimes around the earth. But this conception is "absolutely identical" with that of the Egyptians (*Histoire* 71). Thales shows thus no originality, nor did he have any scientific interest. His historical role was to import into Greece a set of empirical knowledge from the East. The introduc-

tion of this set of empirical knowledge was the “spark” that lit the Hellenic genius and that woke it up from its state of unconscious slumbering (*Histoire* 54).

ii. Anaximander

Having first stated that Anaximander was not a formal disciple of Thales, Tannery starts with a description of the scientific instruments that Anaximander may have used and invented, and the results that he could establish on the basis of the use of such instruments. Apart from the gnomon, he probably used a *polos*, i.e. a hemispherical sundial. The construction of the *sphairos* that the tradition attributes to Anaxagoras was based on the *polos*. The use of these two instruments will provide the Greeks with the most important results in observational astronomy; already in the time of Anaximander one could determine the path of the sun on the zodiac and distribute the fixed stars on the surface of a sphere. But if Anaximander could use at least some Oriental knowledge in the field of astronomy, the creation of the first map of the world, is entirely his own innovation. It is all the more noteworthy that the first geographer is thus presented in our sources not as a traveller.

In the next phase, Tannery gives a brief summary of Anaximander’s “system”, in which he follows the reconstruction proposed by Gustav Teichmüller. Anaximander started to build up his view of the world from some basic empirical data: the daily revolution of heavenly bodies and the observation that such a circular movement draws the heavy in the middle and pushes the light to the periphery. The eternal circular movement produces the concentric wheels of fire and the concentration of heavy earth in the middle and the ensuing cosmological events leading up to the appearance of various celestial phenomena and life on earth. But the resulting state of affairs is not stable because the celestial heat will ultimately destroy everything in the middle. Yet, according to the first fragment of Anaximander, the heat will receive its due punishment, the original state of confusion comes back, and everything can start again: the infinite periodic succession of worlds never started and never will come to an end. Anaximander’s system is at the same time a substitute for older theogonies: the Infinite, the Revolution, and the heavens that are born from them are divinities (*Histoire* 90).

This general characterization of the cosmic system of Anaximander is followed by an examination of the details. This is also the most original part of the chapter where Tannery departs from Teichmüller and asks some of the most important questions that dominate the discussion of Anaximander’s cosmology ever since: what is the distance of the rings of fire, what is their exact shape, how can the fire of the larger circles penetrate the cushion of air covering the inner circles and so forth. But this is also where Anaximander shows his own strength (*Histoire* 93):

“En essayant de pousser aussi loin que possible la restitution du système cosmique d’Anaximandre, nous l’avons traité comme une hypothèse scientifique; nous avons pu, de la sorte, constater chez son auteur une imagination claire et précise, arrivant à coordonner l’ensemble des phénomènes de la nature sous une représentation aussi erronée que l’on voudra, mais incontestablement nette et saisissante. Toutefois cette netteté, cette précision n’existent que dans les images matérielles qu’il crée; on ne peut aucunement les attribuer aux concepts métaphysiques désignés par certains termes qu’il emploie”.

This is where Tannery turns to the discussion of the *apeiron*, and his discussion is based, once again, largely on Teichmüller. The discussion of the *apeiron* cannot but be based on Aristotle's testimonies. But Tannery's methodology will lead him not only to question the interpretations of the historians of philosophy but also to be sceptical about the historical value of Aristotle's testimonies on which these interpretations are based (*Histoire* 94):

“On remarquera comment notre plan nous a amené à traiter maintenant en dernier lieu une question qui, pour les historiens de la philosophie, forme au contraire le point de départ de toute étude sur Anaximandre. Il est naturel qu'en abordant ainsi son système, les mêmes historiens s'en soient rapportés à l'opinion courante, c'est-à-dire à celle d'Aristote, qui cautionne tous les autres; la marche inverse que nous avons suivi va nous donner une raison péremptoire pour rejeter cette opinion. Il convient donc que tout d'abord nous examinions le degré de confiance que nous pouvons avoir dans le témoignage du Stagirite”.

It is customary to translate Anaximander's *apeiron* as “infinite”, largely in the Aristotelian tradition. It is not impossible that someone in Anaximander's age could imagine space as being infinite. But there is a serious limitation. Anaximander's starting point was the eternal rotation of matter; yet the circular movement of matter extending to infinity is such a logical impossibility that no one possessing Anaximander's precise scientific imagination could ever imagine. We have to maintain therefore that Anaximander used the word in its other possible sense, i. e. “indeterminate”. The *apeiron* is the spatially limited primordial mass of matter that contains the basic opposites and that is something airy, containing also some moist vapour. This analysis is the first occurrence in the book of what will be one of Tannery's interpretative foci: the relationship between spatial extension and infinity, on the one hand, and the apparent daily revolution of the heavens, on the other.

The final part of the Anaximander chapter is meant to demonstrate the utility of the history of science: how a review of the hypotheses of the past enables us to put into perspective the currently accepted theories, point out the origin of the concepts they use, and thus to formulate a historical, philosophical critique of them. The section starts with a general discussion of the different theories concerning the beginning, evolution, and end of the world. Tannery argues that the only two philosophically and scientifically viable views are the ones formulated respectively by Anaximander and Xenophanes: the first posits an eternal succession of generated and perishing worlds, while the second denies that the world has a beginning and an end and proclaims that it is in a permanent state of dynamic transformation. Even though trying to choose between the two have remained the preoccupation of philosophy and science ever since, we have to realize that these questions are at the fuzzy border that separates the knowable from the unknowable. The final eight pages of the chapter provide a presentation of the theory of entropy, the most recent theory about the end of the world. This theory does not correspond to either of the two general models, and is the result of the modern idea of unidirectional, linear progress. Tannery argues that this theory is scientifically unfounded and that it is of questionable philosophical value. This closing section of the Anaximander chapter

is the one part of the book where Tannery displays some of his theoretical ambitions, views on contemporary science, and ideas on the relevance of the history of science. The section, on the whole, is rather unclear and the arguments are torturous. It is good that Tannery did not continue the book in this vein.

iii. Xenophanes

Xenophanes is the first author treated in the book who demonstrably knew Pythagoras' doctrines. Accordingly, the chapter on Xenophanes is already dominated by Tannery's main preoccupation in the rest of the book: the quest for the traces of Pythagorean doctrines in the fragments of the different physiologists. Almost the entire first half of the Xenophanes chapter is taken up by the discussion of the emergence of such general concepts as 'infinity', 'void', and 'space', and the role of the Pythagoreans in that development, with hardly any mention of the assumed hero of the chapter.

The presentation of Xenophanes proper then starts with the claim that he was not a real philosopher, but a poet, and primarily a humorist; the sceptical traits in him are aspects of his humoristic and non-systematic doubt. All in all, Xenophanes' ideas, except some paleontological observations, are scientifically insignificant and are prompted by a poetic imagination. He was, however, not an uninteresting thinker and his influence on theology is considerable. As we could predict from what we have learnt at the end of the previous chapter about the two main cosmological patterns, Xenophanes' views can best be explained by contrasting them to those of Anaximander. Xenophanes denied that the cosmos, his one god, has a beginning or an end in time. But the main thrust of Tannery's analysis of Xenophanes revolves around the relationship between the concept of infinity and the observable daily revolution of the celestial bodies. The thesis of the immobility of the cosmic god is a sign that Xenophanes denied the daily revolution of the whole – hence also the fanciful view that the apparently circular motion of the stars – that is those inflamed clouds – is actually rectilinear. Yet it is a sign of the limitations of Xenophanes' scientific interest that although he considered the universe to be unlimited, he denied the existence of the daily revolution for other reasons; he simply did not make the connection between these two and did not have the full concept of infinity. More exactly (*Histoire* 134):

“On doit conclure que Xénophane ne possédait pas pleinement le concept de l'infini et que, si sa négation de la révolution de l'univers a été liée à son opinion sur l'infinitude, ç'a été, non pas par un raisonnement explicite, mais par ce sentiment à moitié inconscient qui fait si souvent la logique des poètes et des femmes”.

The problem, of course, is that according to the majority of ancient sources Xenophanes thought the universe to be finite. To explain this anomaly, Tannery offers a reconstruction of the doxographic tradition according to which Theophrastus first commits a serious error in his report of Xenophanes, and the error is then perpetuated in different forms by all later authors.

iv. Anaximenes

Even though Anaximenes was born too late to know Anaximander personally, he kept the most fundamental ideas of his predecessor: the unity of matter, the eternity of the revolution, and the succession of generated and perishing worlds. He also followed Anaximander in treating the air to be the indefinite, primordial matter. But no matter what the Peripatetics say, the air of Anaximenes cannot be spatially infinite for the very same reason as the *apeiron* of Anaximander: the reality of the daily revolution is incompatible with the spatial infinity of matter. But could it be that Anaximenes distinguished the daily revolution of the heavenly sphere from that of the eternal rotation of the air, as Zeller has suggested? No, because then Anaximenes would have been required to provide a further hypothesis concerning the origin of the daily revolution. Moreover, it still would not solve the problem of the revolution of an infinite mass of matter. In general, Anaximenes' theories do not bring any progress in the history of the concept of infinity.

After this general presentation of Anaximenes' 'system', largely, although not uncritically following Teichmüller,¹³ Tannery turns to the specific astronomical views of Anaximenes. It is in this more original part that he also acknowledges Anaximenes' originality. First comes the determination of the relative distance of the fixed stars: that they are fixed to a solid firmament, which is farther than the orbits of sun and moon. The solidity of the sphere of the fixed stars remains an important postulate of astronomy up to Copernicus. The solidification of the crystalline sphere however poses special problems.

Second, Anaximenes made an important distinction between the stars on the one hand, and the sun and the moon on the other. The stars, as we know, are like nails in the solid firmament. The sun and the moon, in contrast, are disks that have one illuminated and one dark side. This provides an explanation of the eclipses and this explanation, although still erroneous, is a necessary and important stage which leads to the true theory. If the phases of the moon are explained by the turning of its disk, showing partly its luminous, partly its dark side, it needs only a further step to recognize that the moon is dark in itself and gets its light from the sun.

In terms of physics, Anaximenes' greatest contribution was that "he was the first to affirm with precision the unity of matter, or rather that of substance" (*Histoire* 158). By this, Tannery means both hylozoism as the opposite of substance dualism and monism as the opposite of the atomist doctrine in both its ancient and contemporary formulations. Anaximenes' importance is all the greater as, in Tannery's view, dualism could never take the upper hand in philosophy, whereas the atomist theory remains a hypothesis, and the modern theory of ether is scientifically indemonstrable. Moreover, the materialist doctrine is incapable of explaining the origin of life and is logically inferior to hylozoism. The final part of the Anaximenes chapter is thus parallel to the end of the Anaximander chapter: its aim is to show the relevance of ancient theories in the critical evaluation of the relevant current scientific hypotheses and in setting the limit between the knowable and the unknowable.

13 See *Histoire* 146–7.

v. *Heraclitus*

The chapter on Heraclitus is again determined by Teichmüller's general interpretation. Tannery takes over Teichmüller's overall characterization of Heraclitus as a theologian. In the main outlines of his system, in the question of the unity of substance and the cyclical cosmology, Heraclitus follows his predecessors. Because of religious motivations, he however takes fire to be primary. In general, Heraclitus pushes the scientific questions into the background and wishes to show the work of divine intelligence in nature. Heraclitus, on the other hand, is philosophically significant because he introduces two questions that would occupy philosophy for the ages to come. First, whether the common Logos, the ultimate organizing principle, has consciousness and personality. Second, whether the souls retain their individuality after death. These questions are rejected by science as belonging to the domain of the unknowable and it is noteworthy that they first appear in the work of a theologian.

There comes a long explanation, based on Teichmüller, explaining the profound yet indirect Egyptian influence on Heraclitus. This is also connected to the lengthy explanation of 22 B 127 D.-K.¹⁴ according to which the fragment is to be understood on the basis of an obscure and obscene myth reported by Clement of Alexandria (*Protrepticus* 2.34). The Egyptian influence continues in Heraclitus' image of the world, which is thus close to Thales, who had also got his ideas from Egypt. Even the idea of eternal war and eternal flux comes from the region of the Nile.

Tannery finally returns to the two central questions of the Heraclitus interpretation as delineated above. For once, he sides with Zeller as opposed to Teichmüller regarding Heraclitus' eschatological doctrines: the individual soul is born from the divine fire by being detached from the common Logos and in dying it resolves in water. As an exception, the souls of the best can survive the death of the human being and exist for some time. As to whether the divine Logos possesses personality and consciousness – another point of contention between Teichmüller and Zeller – Tannery's answer is that the whole debate is phrased in anachronistic terms. Tannery finally adds that science may sooner or later determine the physiological conditions of the coexistence of individual consciousnesses in communication with one another and that the problem of consciousness may receive a scientific formulation. The metaphysical problem, however, will probably remain just as obscure as it was in the time of Heraclitus.

vi. *Hippasus and Alcmaeon*

This chapter continues the hunt for the traces of the Pythagorean doctrines. Tannery explained Hippasus' role in the divulgation of Pythagoras' mathematical teaching in his monograph on the history of Greek geometry and he summarized the main elements of the story at the beginning of the Xenophanes chapter. This chapter now adds some brief remarks on Hippasus' conception of fire. Tannery opposes Zeller's hypothesis that the source of Hippasus' theory was the doctrine of central fire; Tannery here restates his important claim that the doctrine of central fire appears only with Philolaus. According to Tannery, Hippasus' theory is rather evidence for the early stage of the Pythagorean

14 This is fr. 81 according to the numbering adopted by Tannery.

theory of principles, in which *peras* and *apeiron* were still conceived in material terms: the solid earth as *peras* and the fluid and refined fire as *apeiron*.

The two pages on Hippasus are followed by fifteen pages the main subject of which is Alcmaeon. Yet Alcmaeon, who according to Tannery, is our main source for the reconstruction of Pythagorean physics, is in fact only pretext to discuss Pythagorean astronomy and physics. So, for example, the dualism of Alcmaeon provides Tannery an opportunity to draw a general sketch of the development of the Pythagorean theory of opposites and also the place of the Parmenidean *Doxa* in that development. The major astronomical novelty in Alcmaeon is the distinction between the daily East-West motion of the planets and their proper motion from the West to the East. But this discovery, just as the discovery of the sphericity of the earth and the determination of the temperate zones that the tradition attributes to Parmenides, must be credited to Pythagoras. What is more, the scepticism concerning human knowledge expressed in the first fragment of Alcmaeon is related not to the poetic doubt of Xenophanes, but rather to Parmenides' epistemological distinction between *aletheia* and *doxa*. Yet the source of both Alcmaeon and Parmenides is Pythagoras whose 'scientific spirit' must have been struck by the difference between truth that may receive a rigorous demonstration on the one hand and views that must remain conjectural on the other. The set of mere opinions were open to all disciples of Pythagoras, whereas the demonstrations were reserved to the inner circle. This, by the way, may also explain why Alcmaeon does not know what Parmenides knows, such as the sphericity of the earth, even though both rely on Pythagoras. Tannery discusses the discovery of the reflected light of the moon in this context. He maintains that the discovery is to be credited to Anaxagoras, even at the price of emending Parmenides' text. The sphericity of the sun and the moon was however first introduced by Philolaus.

The closing sections on Alcmaeon's views on sensation, embryology and physiology continue the systematic comparisons with Parmenides. The results are roughly the same: there is no contradiction between the two authors, but Parmenides is the more advanced of the two.

vii. *Parmenides*

The previous chapters have already given a relatively detailed image of Parmenides. But there are some important additions, primarily concerning the *Aletheia*, that add further details and colouring to the previous results. According to Tannery, the main aim of the *Aletheia* is to offer a scientifically demonstrable formulation of Milesian monism in face of Pythagorean dualism. Parmenides follows Xenophanes in denying both the reality of the diurnal motion and the periodic generation and destruction of the cosmos – but not in treating the universe as infinite. In the *Doxa*, by contrast, he expounds his physical doctrines which he thinks are doomed to remain conjectural. Indeed, Parmenides was the first to make the epistemological distinction between what is demonstrable and what is merely hypothetical – even if he could rely on the parallel Pythagorean distinction between mathematics and physics (*Histoire* 223).

Tannery summarizes Parmenides' relation to the Pythagoreans in the field of physics as follows (*Histoire* 219):

“Sur ce nouveau terrain, Parménide n’est pas, à proprement parler, original. Là il se montre réellement disciple des pythagoriens; s’il conserve une certaine indépendance, il marche dans le sens de l’enseignement qu’il a reçu, plutôt qu’il ne manifeste des tendances opposées. On peut bien dire que sa physique n’est pas vraiment pythagorienne, qu’il a fait de sérieux emprunts aux Ioniens. Mais, si cela est exact, on doit ajouter que c’est parce qu’il n’y a jamais eu de physique pythagorienne réellement définie, et que celle de Parménide n’en constitue pas moins le document le plus considérable que l’on possède sur les opinions prédominantes au sein de l’école italique, au moment où il composa son poème”.

By the end of this paragraph it becomes somewhat unclear whether Parmenides remained a faithful follower of Pythagorean physics without much independence or that his physics is not Pythagorean because it was rather Ionian, or again, whether there is such a thing as Pythagorean physics at all – but if there is no such thing, how can Parmenides’ poem be the most important evidence for it? Some, but not all, of these questions will receive an at least partial answer by the end of the chapter. But the most problematic point remains: if Parmenides wanted to prove Ionian monism in the *Aletheia*, why did he show himself a disciple of the Pythagoreans in the *Doxa*?¹⁵

As in the other chapters, the preliminary general characterization is followed by the detailed examination of the scientific views of the author, followed, if necessary, by his philosophical doctrines. Tannery can now start with the *Aletheia* in so far as he treats it as the expression of Parmenides’ *scientific* ideas. Tannery begins by stating that Parmenides is far from being the antithesis of Heraclitus; in reality, as Plato also wanted to show, Parmenides is closer to Heraclitus than to any other early scientist considering monism and the denial of the daily revolution.

Tannery’s ‘key’ to the understanding of the *Aletheia* is that (*Histoire* 221):

“L’être de Parménide, c’est la substance étendue et objet des sens, c’est la matière cartésienne; le non-être, c’est l’espace pur, le vide absolu, l’étendue insaisissable aux sens”.

The second half of this assertion however needs some qualification because, as Tannery has already stated in the Xenophanes chapter, the notion of pure void will only be introduced by the atomists. Thus, Parmenides’ arguments are directed rather against the “relative void” of the Pythagoreans. On the side of being, by positing a limited universe full with continuous matter Parmenides does not question the reality of individual phenomena. Tannery’s interpretation of *Aletheia* is the point that some critics, for example Natorp, found the most problematic in the whole book. The view however has remained influential and has its current defenders.

In the detailed explanation of the dualism of the *Doxa*, Tannery explains that the two material principles correspond to the material, non-abstract understanding of *peras* and *apeiron*, already familiar from the sections on Hippiasus. There is one difference,

15 Tannery’s assertion two pages later that Parmenides “a trouvé le dualisme plus commode pour l’exposition physique et qu’il a jugé impossible d’arriver à la certitude avec une explication monistique des phénomènes” (*Histoire* 223) does not quite solve the problem.

however. By granting preference to light, which is to be identified with the *apeiron*, Parmenides reverses the hierarchy of the two principles. Interestingly, Tannery does not remark on the fact that we have seen the same reversal already in Hippasus.

In some important details of his astronomy, Parmenides follows Pythagoras, most notably in maintaining that the earth is spherical. Yet the main outlines of his cosmic structure corresponds rather to Anaximander's conceptions. In particular, Parmenides' *stephanai*, although multiplied in number, are structurally analogous to Anaximander's rings. The detailed comparison makes Parmenides now a disciple of Anaximander. How does it square with Parmenides' Pythagorean orientation? Either we can say that the Pythagoreans did not have a physical system, or – and this will be Tannery's preferred solution – that they followed in the main lines, and at least in their teaching to the outer circle of disciples, the Ionian tradition of Anaximander. If so, Parmenides can be a follower of the Pythagoreans, indeed the founder of a Pythagorean sect,¹⁶ and at the same time a follower of Ionian physics.

If that was not enough of Pythagoreanism, the last part of the Parmenides chapter is entitled “Les éléments pythagoriques du système” in which Tannery concentrates first on the divinities mentioned in the poem such as *Anankê*, *Dikê* and then on the illumination of the atmosphere during the day.

viii. Zeno

For a truthful understanding of Zeno, the crucial point is correctly to identify his polemical target. Tannery accepts Plato's analysis of Zeno's arguments: if there is plurality, a host of contradictions follows. In particular, Zeno's arguments are not against the reality of motion, but they point out its incompatibility with plurality. But what type of plurality is this? It is not the common sense plurality of the everyman, argues Tannery, but the particular conception of plurality posited by the Pythagoreans. This is all the more plausible, continues Tannery, because even though Parmenides' monism was not conceived as an attack on Pythagorean dualism, it denied their dualism, and thus must have been attacked by them. Zeno's arguments are thus responses to the anti-Parmenidean arguments of the Pythagoreans. Yet Zeno's arguments have a more specific target, not just Pythagorean pluralism as such: they are directed against the Pythagorean view according to which the point is a unit that has a position in space, and that the geometrical bodies are sums of such points. The further confusion between geometrical bodies and physical bodies resulted in the famous doctrine that things are numbers: bodies are the sums of a definite number of points. Zeno's starting hypothesis that ‘the things are pluralities’ attacks this erroneous conception. But Zeno's attack is more thorough because in the Achilles and the Turtle he shows also that space itself cannot be conceived as a sum of points either. Finally, the Arrow and the Moving Lines are arguments against an atomic conception of time. According to Tannery, Zeno's arguments were completely successful and the Pythagoreans after Zeno dropped this crude conception of the point. Atomism, on the other hand, becomes physical atomism that has nothing to do with the mathematical understanding of the concept of point.

16 Cf. also the introduction to the Melissus chapter, *Histoire* 263.

Even though this interpretation of Zeno and the corresponding idea of Pythagorean atomism may strike readers today as far-fetched, it remained seminal all through the first half of the twentieth century: it is still the interpretation presented in the first edition of Kirk-Raven.

ix. Melissus

The Melissus of Tannery is just as much a reaction to Heraclitus as a continuation of Parmenides (*Histoire* 263):

“là [i. e. in Ionia] c’est l’école d’Héraclite qui domine désormais et, raffinant sur l’inconsistance des choses, elle tombe jusqu’à la niaiserie. En face de cette doctrine, le monisme idéaliste devait fatalement surgir; c’était l’antithèse appelée et préparée; il n’a pas d’autre sens ni d’ailleurs d’autre portée. Les deux dogmes se concilient immédiatement, sans amener de progrès intellectuel vers un point de vue supérieur”.

This passage is notable not only because of its original understanding of Melissus, but also because it is the only place where Tannery uses the language and interpretative framework of thesis and antithesis. Remarkably, both the thesis and the antithesis are scientifically insignificant and their synthesis is a dead end. The historical role of Melissus is to elaborate the fundamentals of a monistic idealism and to collect the main arguments that have ever since been used in connection with God: eternity, infinity, unity, immovability.

Aristotle, because of his own preconceptions, has set the interpretation of Melissus on false tracks when he thought that being for Melissus is material. For Melissus the world is but an illusion, in which the existence of space and time are given for us only subjectively; the scientific analysis has no objective value. Tannery continues by a rather unclear analysis of the determination of the ‘being’ of Melissus, which he understands as God. One particularly curious point concerns Melissus’ conception of infinity. It does not mean infinite spatial extension, argues Tannery, because Melissus formally denies the spatial extension of his ‘being’; it refers rather to an abstract conception of infinity, which is the negation of the existence of other beings. Claiming that it is impossible to reconstruct precisely the argumentative chain applied by Melissus, Tannery suggests the following tentative reconstruction: Being is eternal; but in order to affirm its eternity, we must conceive it in its totality; but totality implies infinity and unity.

The chapter ends by a discussion to show that Melissus did not know either Anaxagoras, or Empedocles, or the atomists.

x. Anaxagoras

The rather frustrating section on Melissus is followed by what I consider the best chapter in the book. Tannery visibly very much likes Anaxagoras, and manages to open up new and interesting interpretative directions, especially by his focus on Anaxagoras’ theory of matter. In the general characterization, Anaxagoras is presented as the first real ‘man of science’ could become the model of Plato and Aristotle in their conception of a contemplative life. Interestingly, Tannery also makes the

point that Anaxagoras was the first scientist who was sponsored by the chief of the state, but who, at the same time, managed to retain his intellectual independence.

Tannery starts by Anaxagoras' mathematical activities, putting into focus Vitruvius' testimony about stage settings; this piece of evidence leads Tannery to make some inferences about Anaxagoras' role in the development of geometrical optics. Anaxagoras' major results, however, are the first true explanation of eclipses and of the phases of the moon. Tannery emphasizes, however, that this discovery was based on physical reasoning and not on astronomical observations. Indeed, in other aspects of astronomy, such as the shape of the earth, Anaxagoras was far behind his Pythagoreans contemporaries. His only other notable astronomical theory concerns the Milky Way, but this again is based on pure speculation.

Tannery starts the exposition of Anaxagoras' physics by applying his usual explanatory concepts taken from Teichmüller. Anaxagoras accepts the infinity of the universe, but he also accepts the reality of the daily rotation. He could harmonize these two ideas by delimiting the extension of the rotation. This means that the rotation is not inherent in matter and is therefore not eternal; hence the need for a special cause of the rotation, and this is how Anaxagoras arrived at the conception of *Nous*. It seems to me that it is in the case of Anaxagoras that Tannery can apply most successfully the method taken from Teichmüller. Indeed, it leads him to completely reverse the perspective. For previous interpreters started by hailing Anaxagoras' metaphysical idea of separating matter and mind. Tannery, by contrast, starts with his basic cosmological concepts and from this perspective the importance of Mind is not so much in its metaphysical status, but in his causal role.

Moreover, his physics lead Anaxagoras to the discovery of the truly mathematical conception of infinity in both directions: the rotation can always become bigger just as there is always a bigger number, and there is always a smaller chunk of matter just as there is always a smaller fractional number.

For Tannery, Anaxagoras' most significant contribution is his theory of matter. The governing idea of Tannery's detailed interpretation is that each quantity of matter is characterized by a given coefficient of all types of qualities. In Tannery's reconstruction, when Anaxagoras says that 'in everything there is a portion of everything', he means not that all the homoeomerous stuffs are inherent in any given stuff, but rather that all the pairs of opposites are present in it. This interpretation did not receive wide acceptance; but it has remained one of the available alternatives, which has its current defenders.¹⁷ In developing this theory, Tannery argues, Anaxagoras was formulating a pluralist reply to Zeno. He shows how plurality can coexist with unity if we think that the elements of the plurality can never be totally separated.

Tannery continues by explaining that Anaxagoras' theory of matter is still a scientifically tenable view, which actually has certain advantages over the prevailing atomistic conception. In the less fortunate part of the interpretation, Tannery operates by the concepts of dynamic and mechanical views, and assimilates Anaxagoras' theory of matter to that of Kant. On the other hand, he gives a concise overview of the influence of the Anaxagorean doctrine in which he points out that the Platonic

17 See e. g. Schofield 1980 and Sedley 2008, chap. 1.

theory of participation is seriously indebted to Anaxagoras' theory of matter – this, again, is a view that has its current propounders.

xi. Empedocles

The chapter on Empedocles starts by an examination of Love and Hatred. Tannery in the main lines agrees with Zeller that Empedocles did not quite distinguish between forces and elemental substances. Love and Hatred are not abstract forces, but rather material media that determine or influence the behaviour of the four elements when the elements enter the respective domains of Love and Hatred. These two are in a way comparable to the modern notion of ether. More importantly, they are not the continuations of the Anaxagorean conception of a motive force, but rather the heirs of the Pythagorean opposites.

The general discussion is followed by the examination of particular questions some of which had been raised by previous interpreters, whereas some are introduced by Tannery. Can the elements transform into each other? What is the role of the principle of like-to-like in relation to Love and Hatred? Is there a separation of the elements at the peak of the influence of Hatred or rather a chaotic jumble of the four elements? What is the precise succession of events in the different phases of the cosmic cycle? Is there a zoogony in both halves of the cycle, or only in the phase of growing Love? These questions, that to a large extent still dominate Empedoclean scholarship, receive a clear statement and a detailed reasoned discussion in Tannery's book. This section belongs to the most successful parts of the work.

After the reconstruction of the cosmogony, Tannery turns to the question of Empedocles' relationship to Pythagoras. Somewhat surprisingly, Empedocles is much less a source for the reconstructions of Pythagorean doctrines as Xenophanes, Parmenides, or Zeno. In Tannery's view, Empedocles can generally be characterized as someone who is not really a philosopher. He is interested in physics, but the questions he discusses are less significant than the ones dealt with by his predecessors. More importantly, he does not seek to harmonize his physical views and religious convictions. His most valuable contribution is in the sphere of medicine and it is through his influence on medical authors that his doctrine of the four elements became dominant in other fields as well.

III. ELEMENTS OF A CRITICAL ASSESSMENT

1. Hellenic science: Tannery's periodization

It is worthwhile to start the analysis of Tannery's projects by the words "science hellène" in the title. "Hellène" figures here not as a simple synonym for "grecque", but as a technical term in Tannery's periodization of the history of science in antiquity as he describes it in the Introduction. He distinguishes four ages, each of which lasted for about three hundred years. The first of these, which he calls "hellène", starts at the end of the "age of legends" and ends with Alexander's conquests. I shall come back to this period, the proper object of the book, after a brief characterization of the subsequent periods.

Tannery calls the second period “the period of Alexandrian science”; this corresponds to what we would call the Hellenistic age. This period is marked by the works of the greatest Greek mathematicians (or more exactly geometricians). In their works mathematics becomes an independent science and its practitioners specialist mathematicians. There is a significant progress also in the fields of geography (Eratosthenes) and astronomy (Hipparchus), but no notable results in physics and natural history.

The third period ranges from Augustus to Constantine the Great. Tannery calls it the Greco-Roman period of science, but hastens to add that it is not because the Romans would have added anything to what is Greek in science, but because of the political circumstances. Even if this period includes such great names as Ptolemy, Galen, Diophantus, and Pappus, it does not bring any genuinely original discoveries, but only a rearrangement and systematization of previous results. The level of science is maintained without any real advancement. What Tannery finds most remarkable in this period are the events on the philosophy scene: the growing pre-eminence of Stoicism until the age of the Antonii and then its decline, and the emergence of a unified Greek philosophy in what Tannery calls the syncretism of Plotinus. This amalgamation of previous threads is an honourable albeit finally unsuccessful attempt to preserve Hellenic culture in face of the growing influence of Christianity.

Tannery calls the last three hundred years of Greek science “the age of commentators”, adding that it can just as well be called “the age of decadence”.¹⁸ For Tannery, the only objective of the authors of this period is to write commentaries and make compilations for the sake of writing further commentaries and in order to teach the knowledge acquired by previous ages. There is some original work going on in medicine and mechanics, but perhaps the most important development is in chemistry in the form of alchemy. One remarkable feature of Tannery’s characterization of this period is his insistence that it does not end with the closing of the school of Athens: one should not ignore the works of Simplicius, Philoponus, and Olympiodorus.

Let us now return to the proper subject of the book, the age of “science hellène”. This period can justifiably be called thus because it is during this period that the genuinely Greek scientific spirit reveals itself in all its prodigious inventiveness and productivity. When the period starts, there is no science, when it ends there are two great monuments of science that will have the largest influence on later ages: the œuvre of Hippocrates in medicine, and that of Aristotle in physical, natural, and theoretical sciences. Just as importantly, this age produced those fundamental results in mathematics that are preserved for us in the writings of Euclid and Apollonius.

What is most remarkable for us in this periodization is that Tannery does not draw the line between archaic and classical, and does not distinguish the Presocratics (or Preplatonic) from what comes after, but considers the period continuous until it ends with the first generation of Peripatetics. Tannery’s Hellenic age thus coincides with Hegel’s first *Hauptperiode*. Tannery’s reasons for not taking Socrates as a dividing figure are however obviously entirely different from those adduced by

18 Indeed, he sometimes calls it “the age of decadence”; see e. g. *Histoire* 14.

Hegel. From the point of view of the history of science, Socrates (or the Platonic Socrates of the *Phaedo*) is not a turning point, because – I presume – Socrates (or the Platonic Socrates) is simply not part of that history. By ignoring Socrates and his impact on Plato, and by concentrating only on what is significant in Plato from the point of view of the history of science – such as the myth of Er, the cosmology and physics of the *Timaeus*, and the traces of the assumed Pythagorean influence in Plato – Tannery can claim that Plato is an organic continuation of the science of his predecessors. It remains true even if Plato is a philosopher and not a “physiologist” as the thinkers before him (*Histoire* 11). Similarly, the figure of Eudoxus for Tannery is “le type du *sophiste accompli*” (*Histoire* 2), who manifests the same lack of specialization as the *sophoi*-scientists of the 6th century as opposed to the professional mathematicians of the Alexandrian period. And there is nothing in Aristotle’s approach to science, or in his scientific results, that would set him apart from the previous generations of *savants*.

Tannery has two reasons for setting the boundary elsewhere. First, that, as he writes, Alexander’s empire unduly expanded the limits of Hellenism and thus led to its complete transformation. Although Tannery does not say it in so many words, the implication is that the growing cultural contacts with other peoples deluded the genuine Hellenic spirit. The result is a series of long periods of stagnation in most fields of science.

The second reason stated by Tannery is not internal to the events, but is formulated from the point of view of the historian: the historical surveys of the first generation Peripatetics, by being our principal ultimate sources, require a uniform methodology for the study of the whole previous period, whereas a different methodology is needed for the assessment of the works of later ages.

Yet Tannery’s characterization of the subsequent Alexandrian age is significant. He claims that the scientific spirit of the Hellenic age is to be contrasted with the fundamentally practical orientation of the Hellenistic schools. The ethical focus of this new intellectual attitude blocks the development of what Tannery calls the “theoretical sciences” and shows no great interest in the natural sciences. At the end of the day, Tannery’s periodization is based, at least partly, on the very reason that is operative in a periodization that treats Socrates as the turning point – with the non-negligible difference that Tannery makes practically no note of Socrates.

Tannery’s proclaimed objective is to make this golden age of science better understood by the application of a new critical methodology. The task is necessary, he writes, because this period remains the most obscure among the four, despite the fact that it had been the most thoroughly studied.¹⁹ Yet Tannery adds immediately after that he will not discuss either medicine or geometry, but speak only about cosmology, general physics and astronomy. Moreover, he stops at Empedocles, thus leaving out not only Plato and Aristotle, but the atomists as well.

19 See *Histoire* 9: “Des quatre périodes que j’ai définies, la première est, sans contredit, celle qui a été, jusqu’à présent, l’objet des travaux les plus nombreux; c’est pourtant celle dont l’histoire reste toujours la plus obscure, et c’est à l’éclaircir, s’il est possible, c’est à rechercher et à appliquer de nouvelles méthodes de critique plus plausibles, que sont consacrées les études réunies dans ce volume”.

This limitation already signals, I think, a remarkable discrepancy between what Tannery announces in the Preface about “science hellène” and what the book actually delivers. We have just seen that he highlights the Hippocratic corpus, Aristotle, and geometry as the most important results of this period – yet he does not treat any of these in the book. How could this book then explain the period without dealing with its most important results? The word “pour” in the title must be taken as at least a recognition of this limitation.

2. Aristotle

This discrepancy, moreover, exposes two further tensions in Tannery’s work. The first concerns the role and assessment of Aristotle. By the end of the book, it becomes unclear what the importance of Aristotle actually is for the history of science – except his influence, which, in Tannery’s view, is often negative rather than positive. Indeed, in most cases Aristotle comes out losing in comparison with his predecessors. For instance, in the chapter on Anaxagoras, Tannery explains in a detailed argument the advantages of the Anaxagorean theory of matter over the Aristotelian doctrine of elements, and adds how regrettable it is that ancient science followed Aristotle instead of further developing the Anaxagorean view.²⁰ It is no less remarkable that among Tannery’s 93 papers on ancient science collected in *Mémoires scientifiques* there is only one related to Aristotle, but even that one is on the Pseudo-Aristotelian ‘Mechanical Problems’ (*Sur les problèmes mécaniques attribués à Aristote*, 1900).

Aristotle’s influence has negative consequences for the task of the historian of Hellenic science as well. First of all, when historians of philosophy erroneously treat the ‘physiologists’ as metaphysicians, they can rely on and find support in Aristotle’s presentation of his predecessors in the *Metaphysics*. Moreover, Aristotle’s motivations for his doxographical surveys, and the corresponding method used in these presentations, result in a highly distorted image. In Tannery’s rather crude conception of the endoxic method, Aristotle wants to destroy the theories of his predecessors by opposing them to one another in order to clear the way for his own doctrines. For this reason, Aristotle highlights and over-emphasizes the differences and conceals the underlying continuity and all the important borrowings among the earliest scientists. In the eyes of Tannery, the historians of philosophy perpetuate basically the same approach in attributing alternative metaphysical systems to the physiologists in so far as the emphasis is always on the differences and contrasts in the presentation of these systems.

As opposed to the method initiated by Aristotle and applied by Tannery’s immediate predecessors, one of Tannery’s main aims is exactly to uncover the underlying continuity and point out how much borrowing there is among the ‘physiologists’ all

20 See *Histoire* 294: “il suffit de remarquer qu’au point de vue scientifique elle [i. e. the Aristotelian theory] est très inférieure à celle d’Anaxagore; aussi doit-on regretter que ce ne soit pas cette dernière que la science antique ait eu à mettre à l’épreuve, au lieu de se mouvoir dans le cadre étroit de la symétrique construction d’Aristote”.

through the period, from Ionia to Elea and back again – continuity and borrowings on which the development of science can be based.

Tannery does not in any way believe in the continuous and linear development of science as his periodization of ancient science and his evaluation of the Aristotelian theory of elements I have just referred to clearly show. He is well aware of the fact that there are periods of stagnation, dead ends, returns, and forgotten discoveries. Moreover, it is not clear that the currently accepted scientific theories are any better, at least from a philosophical point of view, than the much more primitive theories of the ancient. So there is no linear continuity and it is questionable whether science generally goes into the right direction.

Yet Tannery's experience in the history of mathematics and other sciences makes him much more sensitive to the way in which new theories build on and integrate previous results. He assumes that it could not be otherwise in the earliest phase of science either. For him, the Presocratics are not isolated speculative thinkers who work on their own systems constructed from some basic metaphysical intuition, but scientists who are working on the explanation of the same natural phenomena for which they use as much as possible of other theories known to them. This is in stark contrast with the largely ahistorical doxographical method which puts side by side and oppose to each other alternative, and to a large extent incompatible, doctrines. Tannery moreover emphasizes that the only real school before Plato's Academy was the Pythagorean 'institute', and therefore it is misleading to treat the 'physiologists' according to schools as it was the custom in histories of philosophy.²¹ The chronological method is the only one that can reveal the underlying connections and the often torturous ways in which science develops.

3. Comte and the general history of science

The second tension between the declared aim of the book and what it actually delivers comes, it seems to me, from the contrast between the histories of special sciences and the general history of science. This point is not taken up explicitly in the book, but is implicit in the title and the list of scientific disciplines discussed in it. The title speaks about science in the singular, whereas the Introduction speaks about the different sciences and specifies which are the ones that the book will cover and which are the ones that will be left out.

The distinction between the histories of special sciences and the general history of science comes from August Comte, and is one aspect in which Comte's influence on Tannery remains notable. The modern historiography of science starts with the works

21 It is interesting to see that Tannery apparently mitigated his views on the unimportance of schools during the process of writing because of Diels' *Über die ältesten Philosophenschulen der Griechen* that was published in 1886, so the year before the publication of *Pour l'histoire de la science hellène*. He accepts Diels' conclusion that Parmenides founded a closed school, but contests that Parmenides' poem played such a role in the life of the school that Diels attributed to it, and does not accept that Zeno's treatise should be understood strictly in the context of Parmenides' school (*Histoire* 224–5).

of professional specialist scientists who, with more or less historical sensitivity, made some research on the history of their own fields from the perspective of the contemporary state of the special science in question. Towards the middle of the nineteenth century a more philosophically oriented approach entered the scene with the objective of providing a comprehensive picture of the development of science as such. An early representative of this current was William Whewell (1794–1866) who maintained that a philosophical understanding of scientific knowledge can only come from a historical understanding of the development of science in general. On similarly philosophical basis, but with much grander ambitions, Comte proclaimed the importance of a general history of science in connection to his philosophy of history and his famous doctrine of the Three Stages. The general history of science emphasizes the fundamental unity of science and its role in the general intellectual and social advancement of mankind, whereas specialized histories of the individual sciences artificially isolate that science from science itself. As Comte writes (Comte 1974, 52):²²

“The so-called historical mode of exposition, even if it could be rigorously followed for the details of every science in particular, would remain purely hypothetical and abstract in the most important respect, for it would consider the development of that science in isolation. Far from exhibiting the true history of the science, it would convey an entirely false impression of that history”.

The problem of course is that the programme of this synthetic general history of science is in a dialectical relationship with the specialized histories of sciences. The general history presupposes a sufficient amount of accumulated knowledge about the special histories, but, as we have just seen, the special histories cannot be appropriately undertaken without the general history.

Tannery was much taken by the idea of synthesis and of the general history of ancient science and was often critical of the specialised histories of the individual sciences. Even though Comte's name appears very rarely in the book,²³ the singular of the word “science” in the title must, I would maintain, be understood in this context. But from this perspective the preliminary, preparatory, and fragmentary nature of the book becomes even more visible. It is remarkable that Tannery was unable to produce a synthetic, general history of science even for this period, when most of the individual sciences had not yet even emerged as autonomous disciplines, and when the same individuals produced the better part of the results in different fields. On the other hand, I find it particularly remarkable that in the case of *Pour l'histoire de la science hellène* Tannery completely leaves out those who could be treated as specialized scientists, either as medical authors or figures like Oenopides, and discusses only those who contributed to science generally. And those who are included turn out to be exactly those who are called philosophers by Tannery's predecessors, contemporaries – and, indeed, most of his successors. The question of the applicability of categories like “philosopher”, “scientist”, “savant”, “physiologue” and the

22 Quoted by Kragh 1987, 12, from whom the preceding remarks on Comte are also largely drawn.

23 One occurrence is a reference to Comte's theory of ‘stages’ in connection to Pythagorean numerology: this is what Comte called the theological stage of arithmetic (*Histoire* 207).

fundamental question about the spheres of intellectual activities in the Presocratic age lurk large in Tannery's book, but he never comes to provide a more thorough discussion of these questions, and the little he says about them, mainly in the Introduction, remains somewhat unrefined and sticks to the science-philosophy dichotomy.

Tannery's two other monographs, and all his previous and subsequent papers, bear on the special sciences. Yet his ultimate goal remained until his death the writing of a general history of ancient science. With this aim in mind he tried to expand his expertise into the fields of ancient musical theory and medicine towards the turn of the century. And by the time the chair of the History of Science at the Collège de France became vacant he felt himself able to come out with such a general history, and he actually applied with a course on the synthetic, general history of ancient science. It is worth quoting from a letter Tannery sent to his friend Zeuthen explaining the circumstances in which the Ministry decided against his application. The tone is unusually self-confident – Tannery otherwise tends to be very humble – but the autobiographical information is highly instructive (dated 10th Jan. 1903 – a mistake for 1904, in: Heiberg 1912–1950: 16.675–8.):

“Ce que maintenant vous ignorez peut-être, parce que la nature de vos travaux n'a guère pu vous le faire deviner, c'est qu'en fait j'ai été conduit à étudier l'histoire des sciences par le désir de donner une base scientifique solide aux anticipations d'August Comte, et qu'à une époque où la tendance est plutôt déclarée pour l'étude isolée de l'histoire de chaque science en particulier, je crois être le seul en Europe qui soit capable de reprendre sérieusement le point de vue général du fondateur du positivisme, et en même temps de montrer qu'à côté des histoires spéciales, une histoire générale garde son intérêt, même au point de vue pratique du progrès historique”.

4. *Doxography and Diels*

As we have seen, the Introduction is followed by two general chapters, avowedly based on Diels' *Doxographi Graeci*. The first reproduces Diels' conclusions about the doxographical tradition, on the role of Theophrastus and the reconstruction of Aetius, while the second offers a critical discussion of our sources for the chronology of the period (primarily concentrating on Apollodorus and Sosicrates), and establishes the chronology of the authors discussed in the book, largely but not uncritically drawing on Diels. The doxographical tradition is evidently crucial for Tannery in so far as the scientifically important material is preserved mostly by the doxographers and not so much in the original fragments.²⁴ Chronology, on the other

24 See *Histoire* 16. Tannery also makes some important methodological remarks in the Introduction on the use of the fragments by underlying that it is always necessary to understand them in the context of the text in which they are quoted (*Histoire* 14): “En dehors des questions que peut soulever l'authenticité de ces fragments, il convient de remarquer qu'en thèse générale, ils ne peuvent guère être isolés du texte de l'écrivain qui les a conservés et qui, d'ordinaire, détermine d'une certaine façon leur signification souvent obscure”.

hand, is important for him for the reasons discussed in the previous sections: it is only on the basis of a sound chronology that one can establish the lines of influence and the directions of borrowing.

On all these points, Tannery accepted the complete authority of Diels. As I mentioned in the outset, Tannery not only recognized the value of Diels' results very early, but also applied his methodology to the history of mathematics in the studies collected in the book called *La géométrie grecque. Comment son histoire nous est parvenue et ce que nous en savons* that was published in the same year as *Pour l'histoire de la science hellène*. Tannery's main claim in that book is that Eudemus' works on the history of mathematical sciences were subject to the same treatment as the *Physikon doxon* of Theophrastus: they formed the basis of compilations and extracts, and these were the immediate sources of any reference to Eudemus' works posterior to the fourth century CE. In particular Proclus' intermediary sources were Porphyry and Geminus, whereas Simplicius and Eutocius used a compilation by a certain Sporos of Nicea called Χρία. If Eudemus for the history of mathematics is what Theophrastus is for the physical sciences, then Geminus and Sporos of Nicea are the equivalents of Aetius for this history. Tannery considered these findings so important that he added a brief summary of them at the end of the Introduction of *Pour l'histoire de la science hellène*. It is worth noting that the papers in which Tannery first formulated these conclusions were published already in 1882, only three years after the publication of the *Doxographi Graeci*. So when Albert Rivaud writes about Tannery in 1913 that (Rivaud 1913, 179 and 204)

“Tannery a joué, en ce qui touche l'histoire des sciences, un rôle analogue à celui que joue M. Diels, en ce qui touche l'histoire de la philosophie, et il n'avait pas eu un Zeller pour lui frayer la route”

it is important to add that Diels himself “a frayé la route” for Tannery.

In the chapter on doxography Tannery almost completely accepts Diels' results, while in the chapter on chronology he formulates some new hypotheses and voices some disagreements. One notable correction he suggests concerns the date of the eclipse supposedly predicted by Thales. On the basis of a rather complicated reasoning involving also the period of the day in which the three possible eclipses were visible in Athens and elsewhere in Greece, Tannery argues that the eclipse in question is that of the year 610 and not the one in 585. Tannery evidently thrives in the combinatorial exercise of comparing and harmonizing different calculations, taking also into consideration astronomical factors. It also provides him with an opportunity to make some remarks on the complementary competences of the historian and the astronomer.

The other remarkable modification he introduces concerns the absolute dates of Xenophanes and Anaximenes that also modifies their relative dating. For Xenophanes, Tannery prefers the date probably going back to Apollodorus which places Xenophanes' birth to 620 to the dating in Diogenes Laertius, preferred by Diels, which would put Xenophanes' date of birth 40 years later. For Anaximenes, Tannery opts for a later dating that places the last Milesian after Xenophanes and separates him from Anaximander.

Characteristically, Tannery differs from Diels most clearly in the assessment of Parmenides' *Doxa*. For Diels, the dualism of the *Doxa* is a reaction to the role of the opposites in Ionian physics, whereas for Tannery it is part and parcel of the Pythagorean influence on Parmenides. The confusion in the paragraph I quoted above from the Parmenides chapter that describes Parmenides' relationship to both the Pythagoreans and the Ionians may actually be a result of Tannery's attempt to mitigate his own position and make it somehow compatible with that of Diels.

5. Teichmüller and the "history of concepts"

The second most important direct and acknowledged influence on Tannery's book undoubtedly comes from Teichmüller. Gustav Teichmüller (1832–1888) was a student of Trendelenburg. He was first a professor in Basel and then, until the end of his life, taught in Dorpat (now Tartu, Estonia). In his later systematic works he developed a form of personalism called "perspectivism" which shows the strong influence of Leibniz. But he started his career with a series of publications on Aristotle, mainly on the *Poetics*. The books on Aristotle were followed by Teichmüller's studies on the "history of concepts". First came the *Studien zur Geschichte der Begriffe* (Berlin, 1874), then the *Neue Studien zur Geschichte der Begriffe* in three volumes (Gotha 1867–1879). Even though Teichmüller's governing idea in this set of books was that the history of philosophy should focus on the development of ideas or concepts, these books are actually collections of essays mostly concentrating on individual ancient philosophers, primarily from the Presocratic period. Apart from a study on Plato and another one on Plato and Aristotle, the first book contained two essays on Anaximander, one on Anaximenes, and one on Xenophanes. From the second book the entire first volume and about half of the second volume is dedicated to Heraclitus. In the remaining part of Volume 2, he discusses the influence of various Presocratic philosophers on the Hippocratic *De diaeta* and presents some "Aphorisms", shorter essays on ancient philosophy. Volume 3 is a study entitled *Die praktische Vernunft bei Aristoteles*.

Teichmüller's influence is decisive in the chapters on Anaximander, Anaximenes and Heraclitus. To give some examples: Teichmüller is Tannery's source for the idea that Anaximander's *apeiron* is not spatially unbounded but qualitatively undetermined; in the Heraclitus chapter Tannery accepts Teichmüller's general characterization of Heraclitus as a theologian, and spends much of the chapter to summarize Teichmüller's theory about the influence of Egyptian mythology on Heraclitus' doctrines and expounds Teichmüller's rather fantastic interpretation of 22 B 127 D.-K. Small wonder that Tannery got castigated by his critics for his reliance on Teichmüller. Rivaud called Teichmüller Tannery's "mauvais génie"²⁵ and Natorp wrote that "Insbesondere ist es ein wahres Unglück, dass für Tannery gerade Teichmüller eine Autorität ist".²⁶

25 Rivaud 1913, 209.

26 Natorp 1889, 207.

I do not wish to contest that Rivaud's and Natorp's judgement is basically correct, especially in the case of Heraclitus. Yet, if one takes the trouble to read Teichmüller's books, it becomes much easier to see what could attract Tannery. This is how Teichmüller in one of the Aphorisms in the second volume of *Neue Studien* summarizes his main results in his studies on the history of concepts: "das Verständniss der Metaphysik der Alten unumgänglich eine vorgehende Bekanntschaft mit ihrer Physik voraussetze".²⁷

This is the reason why Teichmüller as a principle always starts with the examination of the physical doctrines of the Greek thinkers. He severely criticizes other interpreters for having treated the specific, physical, astronomical doctrines of the ancients "als blosse Curiosität" (ibd.). He is particularly critical with those who think that the physical texts are "symbolic" and actually refer to ethical or metaphysical doctrines. He thus rebukes Schleiermacher for having treated the Heraclitean saying about the sun being new every day as speaking about an ethical principle and about the order of the world in general – no, says Teichmüller, we should examine the concrete, astronomical meaning of the fragment. Teichmüller was of course even more critical of Zeller who could sometimes go so far as to think that even Heraclitus' fire should be given a symbolical interpretation (ibd.). In his own treatment of Heraclitus, Teichmüller starts by stating that Heraclitus was "kein Naturforscher" (ibd.), but then continues by a detailed examination of Heraclitus' fragments about the path of the sun, which he interestingly connects with the fragments about the identity of Dionysus and Hades. Then he follows by a lengthy discussion of Heraclitus' theory of elements, the stages of the cosmogony etc. It is only at page 84 of the book that he turns to such "general concepts" with a heavier metaphysical baggage as generation and perishing, the flux of things, fire as principle, harmony, *Logos*, and so forth.

In my own view Teichmüller's interpretation of Heraclitus' cosmological fragments is often interesting and not without value. Just to give one example: Teichmüller was the first to suggest that in what we know as Heraclitus 22 B 120 D.-K., the *ouros* or "warder" opposite the Bear (*arktos*) must be the Arkturos; a solution that was rediscovered by Charles Kahn almost a hundred years later.²⁸ This makes it even more curious that Tannery took over relatively little from these suggestions (he completely leaves out the discussion of 22 B 120 D.-K. as well), and concentrates instead on Teichmüller's mythological interpretations and theories about the decisive Egyptian influence on Heraclitus. These sections on Heraclitus fit rather strangely with Tannery's general project and are arguably the weakest parts of the whole book.

Tannery also followed Teichmüller in his interest in "the history of concepts". The gradual emergence of the concepts of infinity, void, and space run through the whole book, and give the specific character to the chapters on Anaximander, Xenophanes, Anaximenes and Parmenides. Teichmüller's concepts are however applied most successfully in Tannery's original interpretation of Anaxagoras. It seems to me that Teichmüller's approach focusing on the history of concepts could suit Tannery

27 Teichmüller 1867–1879 vol. II, 273.

28 Kahn 1964; Kahn acknowledges Teichmüller's priority in Kahn 1979, 319 n. 190 on the basis of Marcovich's reference to Teichmüller in the discussion of the fragment.

very well also because it emphasized the continuity of the development as opposed to the systematic contrasts of the doxographical method.

One can imagine that for Tannery, Teichmüller's emphasis on, genuine interest in, and thorough, although sometimes farfetched, discussion of cosmological and astronomical details were revealing and refreshing. It is true that Teichmüller remained a historian of philosophy, who continued to treat the ancients as philosophers, whose ultimate interest was still in metaphysical and ethical doctrines.²⁹ Yet Teichmüller thought that the ancient thinkers started not with abstract speculations, but with the intention of explaining the physical world and the diverse natural phenomena disclosed to them by the senses. These very ideas return, slightly transformed, in Tannery's fundamental convictions about the *savants hellènes*. Tannery could carry Teichmüller's project one step further and then take the decisive move: those physical, cosmological, astronomical theories are interesting in themselves, for their own sake, and fully entitle us to call those who invented them scientists. Indeed, there is considerably more of science in these works than philosophy, and these people are much more aptly called scientists than philosophers.

All this, I think, could ground Teichmüller's authority for Tannery and explain why he followed him also on points where he should not have. Tannery did not feel at home in the field of philosophy, and he naturally chose a guide with whom he could agree on some fundamental questions and whom he could consider as a natural ally in his disagreements with such great authorities of the field as Zeller.

IV. THE PYTHAGOREANS

Thus far I have been speaking about the decisive influences on Tannery's book, and the way in which he more or less creatively built these into his project. There remains however one crucial feature of the book that is entirely Tannery's own: the quest for the traces of Pythagoreanism. Tannery's fascination with Pythagoras no doubt comes from his studies on the history of mathematics, where he considers Pythagoras to be the most important figure who determined once and for all the entire course of Greek mathematics. This fascination is then carried over to other scientific domains with the curious result that the Pythagoreans appear to dominate the sphere of physics and cosmology as well even though, as Tannery repeatedly states, they probably did not have their own developed physics and cosmology, and even if they did have, they ascribed secondary importance to it. Yet authors either follow the Pythagoreans or formulate their doctrines and arguments against the Pythagorean views. This is why the search for Pythagoreanism can dominate the chapters on Xenophanes, Hippasus and Alcmaeon, Parmenides, and Zeno, but other chapters contain some remarks on the history on the history of Pythagorean institutions and doctrines as well.

29 Teichmüller 1867–1879, vol. I, 14: “Weil man gar zu schnell immer an die interessanteren ethischen und metaphysischen Lehren Heraklit's geht und die einfacheren Fragen der physischen Weltauffassung vernachlässigt, darum verwickelt man sich auch in der Erklärung jener, und darum lege ich grade den ganzen Nachdruck auf die physischen Voraussetzungen; denn die Physik und die Metaphysik der Alten gehen immer brüderlich Hand in Hand”.

In view of this general trait of the book, the absence of a chapter dedicated to Pythagoras or the Pythagoreans becomes even more conspicuous. Tannery gives a justification for the lack of such a chapter in the Introduction (*Histoire* 13):

“les documents relatifs à l’ancien pythagorisme sont tellement contradictoire et d’une authenticité tellement douteuse, que j’ai n’ai pas, pour le moment, jugé à propos d’aller plus loin”.

At the end of the day, it remains the task of the reader to put together the *disiecta membra* of Tannery’s hypothesis concerning Pythagorean physical science – and it is not always clear that the pieces of the puzzle fit together.

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