Empedocles of Acragas

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His Theory and the Exact Sciences

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In memory of my parents and my teachers

Πᾶνα καλῶ κρατερόν, νόμιον, κόσμοιο τό σύμπαν
οὐρανόν ἠδέ θάλασσαν ἰδέ χθόνα παμβασίλειαν
καί πῦρ ἀθάνατον˙τάδε γάρ μέλη ἐστί τά Πανός.

I summon mighty Pan, protector of the shepherds
The sublime universe, the skies, the sea
The sovereign earth and the immortal fire;
As these constitute the elements of Pan.

—Orphic Hymn to Pan

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PREFACE

Although there are more extant fragments of Empedocles' work than of any other Presocratic philosopher, it is still estimated that they represent only a small part of his work. Indeed, ancient sources (doxographic tradition and other secondary sources) attribute a huge volume of works to him but, despite it all, the extant fragments are only from two poems, *On Nature* and *Purifications* (experts estimate that the fragments represent approximately 15% of the total). Of course, this is not enough for a satisfactory interpretation of his work and analysis of his notions but, luckily, the gap is covered to a certain extent by the existing testimonia, most of which come from Aristotle (who does not always agree with Empedocles' views), and there are also quite a few from Theophrastos and Aetius, amongst others.

According to his biography, his works covered many fields from Poetry to Medicine and Engineering, and from Physics to Theology and Politics. He was indeed a "multi-sided thinker" as A.A. Long describes him and this, together with his arrogant character and pompous appearance, have led some people to consider him a miracle-worker, a shaman, rather than a philosopher. However, the careful reading of the fragments of *On Nature*, especially by one who is somewhat familiar with the Exact Sciences, reveals an impressive side of his thoughts and proves that, although Empedocles was active in many fields, above all he was a great natural philosopher.

Interpreting and deciphering the poetic, emotional, and sometimes ambiguous language of his verse (he has written in epic verse) is not an easy task but, at the end of the exercise, the results are clear and show that Empedocles, based on the judicious use of his senses and mainly on his mind (intelligence), postulated, as early as the 5th century BC, notions which are similar to today's basic theorems of Exact Sciences.

Professor M.R. Wright, in her excellent book on Empedocles, writes "Perhaps the most profitable way forward in work on Empedocles will come from a study of his place in the history of science". This book is an effort in this direction. Whether it is successful or not is for the reader to judge.

Athens July 2018

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CHAPTER ONE

INTRODUCTION

The magnificence of natural phenomena, the harmony of the universe, the violence of such tectonic phenomena, as earthquakes and volcanoes, as well as the splendour of the starlit sky, could not but raise questions within the Mind of man and, at the same time, urge him to seek answers. Despite their grandeur and their imposing character, Homer's epics, Hesiod's *Theogonia* and the orphic beliefs, could not provide satisfactory answers to the persistent questions of 6th and 5th century Greek thinkers who, starting with Thales and Anaximander, sought to interpret Creation through an approach that was not religious. Initially this proved to be an arduous undertaking; yet it marked the beginning of a long journey, or rather, of a chain reaction that began somewhere around 600 BC, continues to the present and is certain to unfurl further in the years to come. Regardless of whether Anaximander's or Anaximenes' ideas are nowadays deemed as wrong or even naïve, they were undoubtedly the root of a longstanding process that is still in progress and will continue to develop in response to the human need for greater and more accurate knowledge.

The fascinating history of the origin of science begins with Thales of Miletus and his successors from Miletus, and continues with such brilliant minds as Pythagoras, Xenophanes, Philolaus, Heraclitus, Parmenides, Empedocles, and the Sophists, until it reaches the era of Socrates, Plato and Aristotle who definitively paved the road of modern thought. These thinkers, pioneers in philosophy but also in science, possessed no other tools than their Mind (Nous), the scattered and dubious knowledge of those times, and the powerful and flexible Greek language in which they endeavoured and finally managed to express and define concepts that were completely unknown until then and whose definition was (and for some, still is) extremely complex.

The interminable search for the laws of nature, what Plato called *the battle of the giants with regard to essence*, carried out by the Presocratic thinkers

brought them up against concepts whose full understanding was realised only many centuries later. This, however, did not prevent them from laying the foundations of scientific thought as well as outlining the principles and directions of certain scientific fields. So, despite the absence of numbers, the Pythagoreans laid the basis for theoretical arithmetic and geometry and, even though "matter" and "energy" were not distinct concepts, the natural philosophers were able to define the basic principles of physics and chemistry. In recognition of this contribution, Karl Popper points out that few philosophers are aware of the influence that certain very old notions of Greek philosophy and Greek science have on the most advanced of our scientific theories: on classical physics and chemistry, on relativity theory, on quantum theory, on genetics, and even on molecular biology.

When Empedocles wrote "On Nature", he was already acquainted with the knowledge developed by his predecessors, especially the Pythagoreans and Parmenides. Thus, his work advances knowledge and, in the 5th century BC, he develops opinions that surpass greatly what his predecessors had claimed and which either coincide remarkably or, in most cases, correlate to scientific theories and notions in the fields of physics and chemistry that were realised a lot later (mostly from the 19th century onwards). For these modern theories to be proven, many scientists had to work on and carry out many theoretical and experimental projects; however, until this happened, many different views and approaches were tested through trial and error.

When studying the works of Empedocles, or any other ancient philosopher, we must not overlook the period and the available means through which the philosopher had to formulate and verify his views. In order to formulate his theories, the scientist of the 19th century, and, even more so, today's scientist, could draw on a rich pool of terms, symbols, definitions, etc. - a pool that is still developing as sciences and mathematics keep advancing; and in order to prove them, had a large "arsenal" of instruments and devices at their disposal, an arsenal which, in our days, offers tremendous possibilities. In the 5th century BC, however, none of this was available. Therefore, apart from the postulation of general principles, when Empedocles proposed his theories, he was necessarily limited to a description of the general theoretical framework of contemporary theories which can only *correspond* (and not coincide) with current formulae.

The question, therefore, as to whether or not Empedocles and the other Presocratics qualify as scientists must be answered with these factors in mind.

The main reason for which Empedocles, or anyone else from the Presocratics, is not considered to be a scientist is that their theories lack proof. On the other hand, however, Empedocles (as well as the other Presocratics) share two characteristics typical of scientists: first of all, they believed that they had the ability to comprehend what the universe is and what it is made of and, secondly, that the most important “tool” necessary for the comprehension of the universe is the human mind. Empedocles proceeded and expressed views that were seen as revolutionary or even wrong, both in his time as well as later; today, however, we can safely claim that they were quite prophetic.

A clear answer to this question was given by G.E.R. Lloyd[1] who writes: "Yet despite the achievements of the Near East peoples in the fields of medicine, mathematics and astronomy, it is still reasonable to argue that Thales was the first philosopher-scientist".

In effect, experimental proof of various scientific theories became possible only in the 20th century. As a matter of fact, Erwin Schrödinger, discussing the possibilities open to him in his time (i.e. the first half of the 20th century), argues[2] that the great Atomists, starting from Democritus and reaching Dalton, Maxwell, and Boltzman, would have been deliriously happy had they come across this tangible proof of their hypotheses.

In the ancient world, physics, whose fundamental principle is the law of energy conservation, was not immediately accepted as a science. The available knowledge was scattered and limited to applications for the solution of practical problems. Very possibly, the first "scientific" dealing in physics (which constitutes a vast science) took place in the 3rd century BC, by Archimedes, but he too restricted himself to specific fields (mechanics, hydraulics, etc.) and his goal was usually practical application. The section of heat, in particular, was not incorporated where it actually belongs, that is, in the study of energy forms, until much later, and consequently a huge scientific gap was created which lasted until the 19th century.

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[1] In his book "Early Greek Science" (p. 8)

[2] *Nature and the Greeks*, p. 95. (Greek Translation)

Until then, the belief was that a liquid of undeterminable nature by the name of *caloric* caused heat to happen. Only in 1798 did B. Thomson and H. Davy, independently of one another, question its existence. Davy proved its non-existence by rubbing two pieces of ice that melted despite the absence of an outside heat source. In other words, he achieved the production of heat (that was consumed to melt the pieces of ice) only through the production of mechanical work (the rubbing of the two pieces of ice). Since then, heat has been classified as a form of energy and thermodynamics as the most important field of natural sciences. In 1842, J. Mayer stated the law of energy conservation, and Joule, the mechanical equivalent of heat, which constitute two different expressions of the first law of thermodynamics. A little later, the second law of thermodynamics followed with two equivalent propositions by Kelvin, Planck and Clausius, while in 1902 T.W. Richards and, a few years later, W. Nerst and Max Planck proposed the third law of thermodynamics.

The development of thermodynamics, the core of which is its three laws, contributed greatly not only to the development of the natural sciences but also to technological progress, with internal combustion engines and air conditioning systems constituting the two most typical and best-known examples.

What follows is a reference to the content of the laws of thermodynamics in as simple terms as possible, and with the fewest and most simple mathematical formulae employed, to make the comparison with Empedocles' sayings possible.

According to the first law of thermodynamics, *energy cannot be created or perished*; in other words, a law identical to the energy conservation one. Consequently, if, in a given system, a form of energy (e.g. mechanical) disappears, one or more different forms of energy (e.g. thermal, chemical, etc.) will be produced equal in amount to the form of energy that has disappeared. Let us say that in a system (e.g. a cylinder, inside which a piston moves) with internal energy equal to E_1, heat equal to Q is added. From this heat, work equal to W will be produced on the one hand and, on the other hand, the internal energy of the system will increase to E_2. In other words, the change ΔE (increase) of the internal energy will be:

$$\Delta E = E_2 - E_1 \qquad (1).$$

It will also be:

$$Q = \Delta E + W \qquad (2).$$

Formula (2) is the mathematical expression of the first law of thermodynamics.

With the first law of thermodynamics, the notion of thermal content, or Enthalpy, of a system was introduced - this is usually symbolized with H.
The second law of thermodynamics, according to Clausius, is stated as follows:

Transferring heat from one body to another of higher temperature without the influence of an external heat source is impossible. To express the second law of thermodynamics mathematically, a new thermodynamic quantity was introduced: Entropy - usually symbolized with S.

Entropy, just like the internal energy and the enthalpy of a system, depends only on the initial and final state of the system.

According to a generalized statement of the second law of thermodynamics, all natural processes tend to take place only with an increase in entropy, and the direction of change is such that it leads to an increase of entropy.

Entropy was characterized by the eminent American scientist, J. W. Gibbs, as the measure of “mixtupness” in a system. The meaning of this characterization is that, when one of the “useful” energy forms, e.g. mechanical, electrical, etc.- which are structured and produce work - is converted to heat - which is by nature chaotic, as it is produced by the irregular movement of a body’s molecules - the chaos or "mixtupness" in the system increases.

The free energy (E_f) of a system is that variable which, in reversible and isothermal processes, equals to the amount of work produced. Free energy, enthalpy (H) and entropy (S) are interrelated in the following way:

$$E_f = H - TS \qquad (3)$$

where T stands for absolute temperature (i.e. $\theta + 273$, where θ is expressed in °C).

Finally, the third law of thermodynamics, derived from the work of Planck and others, is as follows:

Entropy in pure crystal solids at a temperature of absolute zero, that is at -273°C is considered to be zero.

While physics, as a science, is founded on the law of energy conservation, the cornerstone of the science of chemistry is the law of mass conservation or the principle of matter conservation. Just like physics, chemistry too was slow in becoming a science, even though, during ancient times, important chemical knowledge existed in Greece and elsewhere. However, this was not organized methodically, and it was useful only in certain practical applications, such as metallurgy, pottery, glass-making, textile dying, etc. and, therefore, did not allow for the extraction of general conclusions.

The state of "sporadic" knowledge lasted until the 4th century AD, when alchemy started developing; an occult science, the main aim of which was the discovery of the philosopher's stone that would prolong human life (the elixir of life) and would convert common metals into precious ones. However, until the 16th century, when alchemy prevailed, a lot of useful information was gathered that was later used in the development of chemistry, while certain alchemists, like the German A. Magnus and the English R. Bacon, contributed greatly to the advancement of knowledge in chemistry.

During the Renaissance, iatrochemistry developed, and the existing knowledge of chemistry was applied in the advancement of medicine. The most distinguished representative of iatrochemistry was Theophrastus Paracelsus (1493-1541). The first scientific approach to the existing chemical knowledge of the time was made by the eminent Robert Boyle (1626-1691) who, apart from his valuable work in the study of gases, developed the notion of the chemical element as the simplest particle of matter, which cannot be further simplified.

After Boyle, the next period was marked by regression, as Georg Stahl's (1660-1734) pseudo-scientific caloric theory dominated; according to which, combustion happens due to the existence of a hypothetical substance in bodies, which was termed "caloric" (phlogiston).

The modern era for chemistry started when, in 1774, the French chemist A. Lavoisier (1743-1794) introduced the chemical scales in the study of chemical reactions. Lavoisier proved the elemental composition of metals, as well as of sulphur and phosphorus, which until then were considered

complex compounds and, in 1777, developed the theory of combustion, as it is known today. Since then, chemistry has developed greatly and from 1828 onwards, has developed in leaps and bounds as Fr. Wöhler produced, for the first time, an organic compound, urea, from non-organic raw materials. Finally, an important landmark in the development of chemistry was the invention of the famous periodic table of the elements that was accomplished by Meyer and Mendeleev in 1869.

In the 20th century, physics and chemistry made incredible progress; instigated in 1900, when Max Planck developed the theory of elementary units, widely known as quantum theory. Einstein's theories followed, with the postulation of the famous equation $E = mc^2$ - where E stands for energy, m for mass and c for the speed of light - which reveals, in a measurable form, the equivalence between mass and energy. Since then, the development of both physics and chemistry has been rapid, and as a result, the adjacent scientific fields (biology, astronomy, cosmology, etc.), as well as technology have advanced tremendously and, consequently, many everyday problems that were once considered difficult or impossible to solve have now been mastered.

As one can see from the brief history of physics and chemistry outlined above, these sciences developed and made significant progress after the 19th century. However, the Greek thinkers of the 5th century BC had already developed, often with remarkable accuracy, many of the principles that permeated them. In particular, with the definition of the **Sphere** as the initial system in balance; of the **Rhizomes** (fire, air, water, earth) as basic elements through the composition of which all matter is created; the pair **Love-Strife** as opposite, yet interrelated forces, the action of which produces changes, but also with his accurate postulation of the law of mass conservation, Empedocles approached scientific truth more than, not only his contemporaries, but also researchers of the 17th and 18th centuries. It is possible that, had his notions not been viewed as remarkable and charming fossils of philosophical thinking, but as scientific or even pre-scientific propositions, the advancement of the natural sciences and of technology would have been speedier.

CHAPTER TWO

HIS LIFE AND WORK

The available information on Empedocles' life is mostly contradictory and, as a result, neither his date of birth nor that of his death has been accurately calculated. In fact, most of the information comes from the famous work of Diogenes Laertius *Lives and Opinions of Eminent Philosophers*.

The only definite information we have about Empedocles' life is that he was born in Acragas, Sicily. Sources are contradictory with regard to the exact date of his birth, but researchers agree that he was born between 495 BC and 490 BC, which means that he was a contemporary of Socrates, Pericles, Sophocles, Parmenides, Xenophanes, Anaxagoras, amongst others.

According to Diogenes Laertius, Empedocles was the son of an eminent and wealthy family. His father was Meton and his grandfather, also named Empedocles, had won the chariot-race in the 71st Olympic Games (496BC). Democratic beliefs were an integral part of family life, his father had helped overthrow the tyrant Thrasideus (470BC). Empedocles himself, abolished the Parliament of the Thousand, when it began adopting oligarchic principles, although when his compatriots nominated him for king, he refused the position.

The identity of his teachers too, remains obscure. According to some information he was the student of the Pythagoreans, Pythagoras' son, Telauges of Hippasus, of Anaxagoras, of Xenophanes, of Parmenides, etc. In fact, it is claimed that because of him and Plato, both of whom published the teachings of the Pythagoreans, poets were excluded from the Pythagorean School. Most likely, Empedocles attended the teachings of the Pythagoreans and Parmenides, but subsequently pursued his own philosophical path.

His appearance was quite impressive, and it is said that in this respect he took after Anaximander. He wore a purple robe, a gold diadem and a

Delphic crown, while his sandals were bronze. Because of his activity, as well as his appearance, his fellow citizens treated him as a god—at least during a certain period of his life—something that he too provoked, as he proclaimed in his *Purifications* (112 DK): "...I tell you I walk among you not as mortal but as an immortal god, honoured by all I think, crowned with ribbons and fresh garlands... "

His activity was multifaceted, and he was considered a miracle-worker, brilliant orator, great philosopher and poet, and political figure with leadership qualities. Many outstanding achievements are attributed to him, as well as a number of miracles, such as, for example, that he was able to postpone rain, or that he managed to keep a lifeless woman, without a pulse, alive for thirty days. Obviously, his actual achievements were so impressive that a legend was created around his name and, as a result, even miracles were attributed to him.

To illustrate his achievements, Empedocles saved the city of Selinus from diseases caused by the waters of a nearby river that was contaminated by funding and engineering the diversion of two clean rivers into the contaminated one, thus diluting and cleaning the waters. By placing skin-bags of donkey skin in the gorges, he succeeded in dehydrating the disease-bearing south winds and thus became known as wind-blocker. He cured Pantheia, whom the other doctors considered doomed. Therefore, it was natural for his fellow citizens to be overawed by him and for him to eventually acquire the fame of miracle-worker. It is not at all surprising that, even during his lifetime, a veil of legend covered his life which, naturally, acquired mythical dimensions after his death. Also contributing to this is his impressive appearance as well as his talent in speaking (Aristotle considers him to be the father of rhetoric); his talent as a poet (various poems and tragedies are attributed to him, it is said that the rhapsody writer, Kleomenes, recited Empedocles' *Purifications* at Olympia); and his great ability as a political leader and his active involvement in the city's affairs, caring and providing for the poverty-stricken, unmarried women of his city.

Information concerning Empedocles' death, and the age at which he died, is also contradictory. Diogenes Laertius claims that he died in the Peloponnese, where his grave was found, but he also cites other versions of the story; for instance, Herakleides says that after curing the lifeless woman, he offered up a sacrifice and celebrated with his friends, when everyone retired in the late evening Empedocles stayed on, but when they

came back later searching for him, he was nowhere to be found. Someone then said that at midnight he had heard a voice calling on Empedocles and, immediately after, had seen a celestial light and lightning. Hermippus says that after curing Pantheia from Acragas, whom doctors had considered doomed, he offered up a sacrifice and directed himself towards Aetna where he disappeared in the crater, out of which one of his bronze sandals flew. Hippovotus claims that he fell off a coach, broke his leg and died of this at the age of seventy. Aristotle says that he died at the age of sixty, while others claim that he died at the age of a hundred and nine.

Considering all the available information, it is most likely that Empedocles flourished between the 81st and 84th Olympiad, that is, between 456BC and 440BC. Therefore, the teachings of Thales, Anaximander, Anaximenes, Pythagoras, Heraclitus, Xenophanes, Philolaus, and Parmenides preceded him, and his contemporaries were Anaxagoras, Melissus, Archelaos, Zeno, Democritus, and Socrates. This means that Empedocles lived during a period when philosophical research had become a tradition, and different "philosophical trends" had already developed. With reference to this period, Karl Popper claims[2] that "the early history of Greek philosophy, especially the history from Thales to Plato, is a splendid story. It is almost too good to be true. In every generation we find at least one new philosophy, one new cosmology of staggering originality and depth. How was this possible? Of course, one cannot explain originality and genius. But one can try to throw some light on them. What was the secret of the ancients? I suggest that it was a tradition—the tradition of critical discussion!!"

Popper, in other words, suggests that during that period of time, every philosophical theory proposed was subject to intense criticism and resting one's case was not an option. Empedocles, a true follower of this school of thought having been taught first by the readings of Homer and Hesiod and then directly by his teachers and having closely studied natural phenomena as these manifested themselves in Acragas, proposed his own views. The influence of his teachers, both immediate and remote ones, is obvious in many parts of his work, while at the same time, his natural surroundings must also have played a significant role in his thinking. The coastal area of Acragas in seismogenic Sicily, a place that also suffers from strong winds and other weather elements, and is near the volcano of Aetna, creates the ideal conditions for the observation and study of natural phenomena.

[2] Karl Popper: The world of Parmenides p.20

Empedocles, of course, as he himself tells his disciple (17 DK), did not rely on his senses alone. Rather he believed in the ability of his Mind (Nous) to analyse whatever it sees and to hear and to delve into things so as to come closer to the true causes of phenomena. At a time when technology was non-existent and, thus, could not help either the ears or the eyes, Empedocles seems to have understood that what he saw and heard were insufficient and, therefore, tried to complement his senses with the power of his Mind (Nous).

The way Empedocles made use of his observations, which were abundant, was similar to that of Thales and other philosophers who lived before him. Certainly, Empedocles had witnessed tempests, floods, strong winds, earthquakes and the explosions of Aetna. It is of crucial importance though, that he did not attempt to explain the phenomena separately, but devised an overall theory which, via the process of elimination, sufficed to explain the variety of the observed phenomena. Observation for Empedocles was nothing more than a stimulus and an occasion for intense intellectual inquiry with high aiming goals.

Whatever knowledge he acquired from the philosophers who preceded him, as well as from his teachers, he viewed critically, using only the parts that fitted his theory after adapting them accordingly.

His written work was rich and even in ancient times was the object of commentary. According to Diogenes Laertius, Aristotle spoke highly of his ability to express himself and considered him to be the father of rhetoric, while in other works of his, for example in *De Caelo* and in *Metaphysics*, he often refers to and comments on Empedocles' views. Others consider him to be the founder of medicine in Sicily. Poems, political speeches, tragedies (according to Hieronymus, forty-three), his thesis on medicine, epigrams, the poem *On Nature* and *Purifications* are all attributed to him. Today, 350 lines from *On Nature* have been preserved, which, according to the Byzantine lexicon *Souda*, consisted of 2000 lines, while another 100 lines have been preserved from *Purifications*. According to Diogenes Laertius, both works, together, consisted of 5000 lines.

On Nature, the real title of which is not known, is written in the Ionian dialect, in dactylic hexameter, and, according to specialists, the writing style has been strongly influenced by Homer and Hesiod. Empedocles' views, as found in this work, had already been subjected to a critical

analysis and commentary, even in ancient times; undeniably the most significant commentator was Aristotle, but he was followed by others - beginning with Theophrastus and ending with Proclus. The fragments that have been preserved until today have been studied, translated and analysed by significant scientists such as J. Bollak, E. Bignone, G.S. Kirk-J.E. Raven-M. Schofield, W.K.C. Guthrie, M. R. Wright, and Br. Inwood, to mention but a few.

A serious challenge that poses itself with regard to the correct study of Empedocles is the classification of the extant fragments in such a way that preserves the initial order of the poem. The difficulty is obvious; however, the classification made by Diels and Kranz in their monumental work *Die Fragmente Der Vorsokratiker*, is considered to be the most scholarly, and it is this classification that is adopted in this study.

From the extant fragments it appears that, in his *On Nature*, Empedocles develops his theory about the creation of the universe as well as that of animals and plants. His thinking is dense and allegorical, and his writing is often complex and ambiguous (Aristotle accuses him of this). The gaps that appear between the fragments make the interpretation of the whole even more difficult and the possibility of mistakes even greater. Nonetheless, thanks primarily to some of the fragments, but also to what had been written about him in ancient times by commentators (Aristotle, Theophrastus, Aetius, etc.) who, most likely, had the entire poem at their disposal, it has become possible to define the basic principles of Empedocles' philosophy, along with the pillars on which it is built. These pillars are the Sphere, the four Rhizomes (Roots), and the pair Love-Strife that are in constant battle.

The other poem of Empedocles from which fragments have been preserved, *Purifications*, is written in a completely different style and has a different content and aim from *On Nature*. In contrast to *On Nature*, which addressed only his favourite and—obviously—knowledgeable disciple, Pausanias, *Purifications* speaks to the people and its content is religious and moralistic, with many orphic and Pythagorean influences.

As has already been mentioned, Empedocles did not limit his work to poetry and philosophy but applied his knowledge and abilities to practice. Apart from his achievements in the field of medicine, where his success must have been such that "miracles", like the one with Pantheia, had been "kept alive" even after his death, he was also an engineer; perhaps the first

one in history to whom the term, as it is used today, can be applied. In other words, he was a technical scientist capable of applying his theoretical principles to practice to solve specific problems. This can be proven by his two well-known achievements: the slowing down and, at the same time, the dehydration of the disease bearing south wind, as well as the cleansing of the contaminated river water. Both achievements were technically possible in the 5th century BC. Therefore, there is no reason to doubt that they truly took place; the understanding and solving of the specific problems, that required important theoretical knowledge, was applied to practice. This, precisely, is the definition of the engineer in our days.

In conclusion, Empedocles managed to carry out such intense, diverse, and impressive work during his lifetime that, when he was alive, and certainly after his death, his life's work was surrounded by a shroud of legend and hyperbole. This, in combination with the style of his poetry as well as his revolutionary—for those times—theories, created certain misunderstandings with respect to his personality and his work. Therefore, some of the scholars who studied his work have called him a shaman, in other words a medicine man, yet most of them have a high regard for the density and depth of his thinking, and the width, the balance and the originality of his work. Noticeably, A.A. Long, editor of *The Cambridge Companion to Early Greek Philosophy*, refers to him as "*one of the most many-sided thinkers"* (p.4), in the same book, Carl A. Huffman considers him (along with Pythagoras) to be "*a great charismatic authority"* (p.77).

Empedocles' work did not inspire philosophers alone, but also poets. The Roman Lucretius was believed to have imitated his style, while Hölderlin, Rolan and Nietzsche wrote works inspired by his life and activities. Costis Palamas, a major Greek poet of 20th century and one of Greece's national poets, wrote an enthusiastic essay on Empedocles, while R. Rolan, in an attempt to give a comprehensive description of his complex personality and after praising his genius and his scientific achievements, proceeds to illustrate the mystical side of his character by saying that *from other viewpoints, this Newton seemed shrouded by a Cagliostro*.

The prevailing view on Empedocles is beautifully summarized in the words of W.K.C. Guthrie, who thus closes the relevant chapter of his monumental six volume work *A History of Greek Philosophy*: "Some love the Greeks for their rational achievement, their classical sense of form, proportion, symmetry and order. Others exalt the romantic, Dionysiac

strain of *enthusiasmos* in which reason abdicates and man feels the ecstatic joy of possession by god. We may be capable of responding to one side only of this contrast, but if we would do justice to the Hellenic spirit we must recognize that it included both; and we are helped to understand this by the knowledge that they were combined not only in one people but in one man, Empedocles of Acragas."

CHAPTER THREE

THE PREDECESSORS

Given the absence of the mass media and the difficulty in reproducing written texts, the dissemination of ideas in the Greek world of the 5th century BC or even earlier is quite amazing. In fact, it remains a true wonder, but one possible explanation is the significant mobility of Greek thinkers, since most of them inhabited more than one places during their lifetime. What is more important though is that critical thinking and discourse were not restricted to a small group of thinkers or to the clergy; on the contrary, it was common in all social classes, extending from the poor to the rich, from the farmers to the military and political leaders. Noble origin or wealth had little or nothing to do with acceptance in a group of thinkers as an equal or even leading member.

The obvious result of this dissemination was the on-going critique of the existing theories; the transmission of these from one generation to the next; an effort to complement, improve them or even refute them; and finally, a rivalry and criticism among thinkers, which naturally resulted in their interaction and interdependence.

This agonizing search for answers to questions regarding the universe and man seems to be as ancient as the motto "know thyself", the origin of which Guthrie, wisely so, attributes to Apollo, and is found in the most ancient of myths and legends as well as in the first texts. In the orphic teachings, whose roots dwell somewhere in the long past (astronomer K. Chassapis, based on certain astronomical observations, claims that the creation of orphic hymns dates back to approximately 1600 BC) but also in Homer and Hesiod, we can find answers to these eternal questions. The search was not geographically limited either. At times, it might have been the spirit of the Ionians that shed more light; at others, the spirit of the Eleatics; however, it was the Greek world in its entirety that, simultaneously and uninterruptedly, participated in and enjoyed the divine privilege of productive reasoning. Thus, views on cosmogony are also expressed around 600 BC by the poet Alcman in Sparta, by Thales, the geometer in

Ionian Miletus, and by Epimenides of Crete. Under such circumstances, it is no wonder that since the 7th century BC, the genius of many eminent thinkers (only some of which are mentioned in the cited timetable) shone in the Greek world; thinkers who not only laid the foundations for the systematic search of truth, but also taught us that the first and foremost "tool" to be used and exploited for this cause is no other than the human (rational) Mind (Nous). Perhaps for this reason, A.C. Crombie claims that "Science, as we understand it today, is a Greek invention. The Greeks discovered natural science, he goes on to argue, when, in their attempt to comprehend the impersonal permanence that hides itself behind the world of change, they conceived the brilliant idea of the generalized use of scientific theory[3]".

Major Presocratic Philosophers (Dates represent approximate floruits)

SOCRATES	430 BC
DEMOCRITUS	420
LEUKIPPUS	440
ZENO	440
MELISSUS	450
ANAXAGORAS	450
EMPEDOCLES	460
PARMENIDES	490
XENOPHANES	530
PYTHAGORAS	530
ANAXIMENES	550
ANAXIMANDER	580
THALES	590

Until the time of Thales of Miletus, the prevailing cosmogonic beliefs had a religious root, their origin being the orphic beliefs; according to these Cronus (often interpreted as Chronos=Time) gave birth to Chaos and Aether, from which the Egg was created, which gave birth to Phanes who, in turn, begot Nyx (Night), from which Gaia (Earth) and Uranus (Sky) were created. In his *Theogony*, Hesiod says that, from Chaos, came successively Erebus (Darkness), Nyx (Night), Aether (Air), Hemera (Day), Gaia (Earth), Uranus (Sky), and Pontus (Sea). Similar were the views of Pherekydes from Syros, according to whom, Zas, Chronos and Earth had always been in existence. Perhaps the only exception is the poet Alcman,

[3] A.C. Crombie, *From Augustine to Galileo*, (Greek Translation) Athens 1994, Vol A, p.26