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The bio-medical comments of Empedocles
A precursor to modern science

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ΑΡΧΕΙΑ ΕΛΛΗΝΙΚΗΣ ΙΑΤΡΙΚΗΣ 2009, 26(2):262–265

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Empedocles (Diogenis Laertius) was born in 490 BC, and lived in Akragas (Agrigento), Sicily. He died in 440 BC and was considered a physician and a philosopher. About 450 verses have been saved from his work, some of which have biomedical references. He observed that plants and animals, including man, are created from four basic elements, which he called "rizomata" (roots or elements). When combined in different ways, these elements succeed in producing all the varieties of vegetable and animal species on earth. Concrete mixtures of these four elements describe each organ or part of the body, thus proposing a genetic and hereditary biology based on the mixture of the four "rizomata". He treated an endemic disease in Selinounta, a nearby city, by opening a canal and emptying stagnating water into the sea. It has also been reported that he cleared plague from the city of Athens by using fire and he did the same thing at his birthplace with the method of disinfection by smoke: *«δι' άψεως πυρών και υποκαπνισμών» "dia apseos pyron ke hypokapnismon"*. Overall, his insight observed through his biomedical comments reveals an admirable precursor to modern medicine.

Βιο-ιατρικές αναφορές του Εμπεδοκλή: Ένας διορατικός προάγγελος της σύγχρονης επιστήμης

Περίληψη στο τέλος του άρθρου

Key words

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Empedocles (Diogenes Laertius) was born in approximately 490 BC in the Greek colony of Akragas, Sicily, and he died around 440 BC. Akragas was a Greek colony founded in the 6th century BC. Empedocles studied medicine (he is referred to as a doctor, a poet, an orator and a philosopher) and had a profound insight into issues of modern biology, specifically genetics and molecular biology, regarding the creation of beings, comparative and experimental physiology, biochemistry and enzymology.[1–3]

The philosophers made many references to Empedocles' works and in this way about 450 of his verses remain. These have been published by Hermann Diels and Walter Krantz, but they are only a small part of his original work.[4]

The following extracts are of interest in terms of biomedicine, according to Hermann Diels and Walter Krantz, and have been translated from Ancient Greek:[4] *"All beings have bloodless tubes over the outside of the body, and at the openings of these outer layers of skin are pierced all over with close-set ducts, so that the blood remains within, while a facile opening is cut for the air to pass through. Then, whenever the soft blood speeds away from these, the air speeds bubbling in with impetuous wave and whenever the blood leaps back, the air is breathed out… Thus, when the soft blood surging violently through the limbs rushes back into the interior, a swift stream of air comes in with hurrying wave and whenever the blood leaps back, the air is breathed out again in equal quantity".*[1,4,5]

This extract reflects Empedocles' approach to the histology of the skin and the respiratory epithelium of the lungs in connection with central and peripheral blood flow. He realized that blood flows into pores beneath the skin which cover the whole body and that it is not exposed to the air. He believed that breathing occurs through both the lungs and the skin pores. Today, we know that pores expand with heat and contract with the cold.[6]

"Refrain entirely from laurel leaves".[4] Laurel leaves are known to be poisonous, with bibliography on this issue and on the chemical identification of poisonous substances.[7] Empedocles, due to his origin from Akragas where laurel thrives, would have been aware of this and following Pythagorean advice, he discourages people from eating them.

Relevant simplistic verses have persisted more easily through tradition than those with obscure philosophical reflections. *"Miserable men, wholly miserable, restrain your hands from beans".*[4] The genetic lack of G6PD in red blood cells results in hemolytic anemia in sensitive individuals when they eat fava beans or expose themselves to the flowers of this plant. The disease is common in Sicily where epidemiological studies show a prevalence of 2% to 30% of the population, depending on the area.

Empedocles, probably based on population observation and clinical experience discourages his fellowmen from feeding on broad beans.[7]

There are other, more psychodynamic explanations for this ban on "beans", where the word is replaced with "testicles". In such a case, Empedocles, as a Pythagorean, denounces sexual hyperactivity, a clue to the profound doctor's morality.[1,5]

Empedocles influenced once more by Pythagoreans, respected and admired animals to such an extent that he refrained from meat-eating.[1–3]

Plutarch in his reports of Ethics (515 BC) writes that Empedocles put up a wall across a gorge through which a sickening, southern wind was blowing.[1,3,8,9] He also recommended to the residents of Selinunta certain sanitary measures, which called for the confluence of three rivers near, which their town, apparently formed swamps.[1,8–12]

Empedocles, according to Diodorus, managed to make Selinunta a healthy town with irrigation works that he funded. By opening up two mighty rivers to the sea, he channeled stagnant water and drained the swamps, making the water drinkable. Obviously, the area suffered from malaria and contaminated water and the works resulted in sanitation, minimizing the scourge of the epidemic of fever which afflicted the people of Selinunta. This sanitation work may well be regarded as the first known public health project, which after detecting the cause of the scourge (in the case of Selinunta, disease and slack water) provided sanitation via drainage works.[6,8–11]

According to Plinius Senior, Empedocles wrote in the Doric dialect a medical essay where he described treating plague in Athens with fire. He is believed to have used fire as a sanitary countermeasure to burn up rodents, intermediate vectors of the disease, thus successfully combating thus the cause of the disease with the efficiency of sanitary measures.

He acted similarly in his hometown, Akragas, by using the method of fumigation.[1,2,8–12]

Empedocles, according to Aetius, believed that during human embryogenesis, joints are formed on the 36th day and limbs on the 49th; that the heart is the first to form in the embryo and nails the last, and that pregnancy lasts for 7–10 weeks. According to Soranus, Empedocles thought that the umbilical cord has four blood vessels, two arteries and two veins, which supply the embryo with nutrients. Rufus from Ephesus reports that Empedocles described the embryo surrounded by membranes, one of which is thinner and called embryonic. For him, the sex of the child is determined by the prevalence of the heat or the cold of the parents during conception, and the offspring's resemblance to one or other of the parents is attributed to predominance of either sperm or the woman's fluids. Twins are the result of excessive sperm that reaches both ends of the womb. He also wrote about the structure of bones, nails, sweat, and tears.[6,8–12]

Empedocles' theory that material and body interaction occur by the penetration of particles through the pores is for Puccinotti similar to the recent theory of endo-osmosis.[10,11] Moreover, he concluded that circulation and breathing (inhalation-exhalation) are interconnected, and that blood runs back to the heart. He visualized the heart being the center of the vascular system and carrier of "inherent warmth". A fall in warmth results in sleep, and its lack in death.[1–3,6] Indeed, he is the first physiologist to view blood as a carrier related to the intake and outlet of air through breathing, and the first to find a connection between arterial and venous circulation, thus inspiring later studies by William Harvey.[10,13]

Empedocles believed that the elements that exist unaltered in all beings (men, animals, and plants) are four, also known as "rizomata" or "roots". The number four is

fundamental for the Pythagorean School. The sum of the first four integral numbers is ten, which for Pythagoreans is the essence of nature.

Deprived of the possibilities of modern scientific research and proof, Empedocles, who was interested in medical and philosophical issues, tried in his cosmology to explain the constituents of life based on a theoretical mathematical process and armed only with his intelligence and senses. He believed that blends of "roots" make up every organ or part of the body and considered that Zeus (fire), Hera (air), Aidoneus (earth) and Nestis (water) are the basic elements that comprise the common connection which man may possibly have with all animals and plants.

These four elements were considered by Empedocles to have originally created the "mold" of life after the Big Bang. He believed that every entity (active or inactive) consists of fundamental particles/elements in certain analogies, which connect not only with similar forces but also with rival forces; hence Love and Strife have existed since the birth of things and life. Health is the product of the balance of the four elements; imbalance results in disease.[1,2]

What is remarkable about his insight is that today we know that the nucleic acids of DNA are four, and that each consists of four kinds of particles equally distributed (carbon, oxygen, hydrogen, nitrogen). Furthermore, the particles in space are four (protons, neutrons, electrons and neutrinos) and the fundamental particles are four (quarks, electrons, neutrini, photons).[1,14]

The unfeasibility of biological experimentation and the lack of research tools did not prevent Empedocles from assuming, via the Pythagorean thought process, the existence of a common factor in all beings, the four roots, which in various combinations, generate life.[2,4]

Empedocles, embracing Parmenidean views, differentiates the mortal from the wise man, who is closer to Sferos, his notion of God, and therefore has the potential for great achievements. It is remarkable that the public sense of the time and the following centuries was impressed by Empedocles' work, and particularly by his conviction that he possessed supernatural and magical powers, including that of bringing a dead man back to life.[1,2,5]

Hermippes mentions that he cured Panthea, on whom every other doctor had given up. According to others, he resurrected Panthea from death; this may have been a case of a hysterical woman's apparent death.[8,9]

Heracledes records Empedocles' achievement of keeping a woman alive who had no pulse or breathing for 30 long days. He called the disease "Apnoun" (not sleeping).[1,2,8,9]

Reports about his death relate a magnificent procession to the volcano of Etna and Empedocles' claim that he would walk on lava. As is usually the case for mystics, excessive admiration was followed by sarcasm and irony. Empedocles is supposed to have failed to walk on the lava and burnt in the volcano.

From the few preserved extracts regarding the initial work of Empedocles, the observer is bound to admire his insight, his multifarious talents and the potential of the Greek way of thinking to act as a precursor to modern science.

ΠΕΡΙΛΗΨΗ

Βιο-ιατρικές αναφορές του Εμπεδοκλή: Ένας διορατικός προάγγελος της σύγχρονης επιστήμης

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Ο Εμπεδοκλής γεννήθηκε το 490 π.Χ. (Διογένης Λαέρτιος) και έζησε στον Ακράγαντα της Σικελίας. Πέθανε το 440 π.Χ. Ήταν γιατρός και φιλόσοφος. Περίπου 400 στίχοι διασώθηκαν από το έργο του, κάποιοι από αυτούς έχουν βιοϊατρικές αναφορές. Παρατήρησε ότι τα φυτά και τα ζώα, συμπεριλαμβανομένου του ανθρώπου, δημιουργούνται από τέσσερα ριζώματα, που συνδυαζόμενα κατά ποικίλους τρόπους επιτυγχάνουν όλη την ποικιλία των ειδών. Συγκεκριμένα μείγματα ριζωμάτων περιγράφουν κάθε όργανο ή τμήμα του σώματος. Έτσι, εισήγαγε μία γενετική και μία κληρονομικότητα βασισμένη στη μείξη των τεσσάρων ριζωμάτων. Ως προς τα ριζώματα, ως βάση των βιολογικών όντων, διαπίστωσε ότι καθένα από αυτά με τη σειρά του αποτελείται από τέσσερα «ομοιομερή στοιχεία». Απομάκρυνε ένα λοιμό που είχε ενσκήψει στην πόλη της Σελινούντας, διανοίγοντας μια διώρυγα για να εκκενωθούν τα στάσιμα νερά.

Ακόμα, με τη φωτιά απάλλαξε την Αθήνα από επιδημία πανώλης. Το ίδιο έκανε και στη γενέτειρά του με τη μέθοδο της απολύμανσης με καπνό: «δι' άψεως πυρών και υποκαπνισμών». Ασχολήθηκε επίσης με την εμβρυογένεση του ανθρώπου και ανακάλυψε το λαβύρινθο του έσω ωτός. Ασχολήθηκε με τη σύνθεση των οστών, των νυχιών, του ιδρώτα και των δακρύων. Μελετώντας το έργο του Εμπεδοκλή θαυμάζει κανείς την οξυδέρκεια και την πολυπραγμοσύνη του και τη δυνατότητα της ελληνικής σκέψης να λειτουργεί ως προάγγελος της σύγχρονης επιστήμης.

Λέξεις ευρετηρίου: Αρχαία Ελλάδα, Εμπεδοκλής, Ιατρός, Ριζώματα, Φιλόσοφος

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