HISTORICAL DEVELOPMENT OF THE
STUDY OF THE EFFECTS OF ELF FIELDS

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HISTORICAL PERSPECTIVE

Consideration of the historical development of the study of biological effects of extremely low frequency (ELF) fields should go back more than 2500 years, when Thales of Miletus (600 B.C.) observed that a piece of amber could be made to acquire the property of attracting small particles by rubbing it with a piece of cloth. Five hundred years later Lucretius of Magnesia (95-52 B.C.) noted the power of lodestone to attract iron.

In 1600 William Gilbert, physician to Queen Elizabeth I published the famous book De Magnete, which laid the groundwork for modern physics. He differentiated between electricity and magnetism, and invented the electroscope, the first instrument for the measurement of electric fields.

Also at about this time, the first academy of science, the Italian Academy of the Lynx, was founded in Rome in 1603. In 1662 the Royal Society of London was incorporated. Besides providing a forum for discussion, the societies began the publication of scientific journals. The first issue of the Journal des Savants as well as the Philosophical Transactions of the Royal Society appeared in 1665. Several mechanisms were thus provided for the dissemination of new ideas and the reports of the results of experiments. This was followed by the invention of the first electrical generating machine by von Guericke in 1660, a spinning globe of solid sulfur, which generated large static electrical charges.
In the early part of the 18th century, Stephen Gray in England demonstrated that the static charges of electricity could be conducted by various materials over distances of several hundred feet, noting that some materials were "conductors" while others were not. In the 1731 Philosophical Transactions in a paper entitled "Experiments Concerning Electricity" Gray described his experiment in which he "electrified" a human subject with a static charge. Concurrently, Stephen Hales suggested that perhaps nerves functioned by conducting "electrical powers." Interest in electricity and its relationship to biology increased and experiments involving electricity and living things became commonplace. The Abbe Nollet expanded Gray's observations on the electrification of the human body, and attempted, without success, to relieve paralysis in patients by administering such charges.

Another Englishman, Abraham Bennet, invented the gold-leaf electroscope, far superior to Gilbert's for detecting and measuring electric charges. Van Musschenbroeck in Holland invented the Leyden jar for the storage of electrical charges, and by the mid-1700's electricity was being generated, stored and transmitted through wires for distances exceeding two miles! Sir William Watson attempted to measure the velocity of an electric current in 1747-48. Although a circuit four miles long was used, his instruments showed no delay. Meanwhile, in 1752, Leonhard Euler, a Swiss mathematician, expressed opinions which influenced the formulation of modern electric wave theory. Many physicians were by now empirically using electricity to treat a number of afflictions, and reporting success. Johann Schaeffer published a book entitled Electrical Medicine in Regensburg in 1752.

Speculation concerning the role of electricity in living things particularly in regard to the nervous system, was increasing, while the most prominent physiologists of the era, Haller at Gottingen and Monro at Edinburgh, rejected these concepts.

Within a few years, Luigi Galvani, who had been interested in the relationship between electricity and biology, acquired the equipment necessary to perform some experiments. In 1786 while dissecting the muscles of a frog leg, one of Galvani's assistants touched the nerve to the muscles with his scalpel while a machine that produced static electricity was operating on a table nearby. Each time the machine produced a spark the muscle contracted. It thus became apparent that electricity did have something to do with nerve activity. Galvani continued his experiments on the relationship between metals in contact with nerves and muscle contraction, reporting his findings in the Proceedings of the Bologna Academy of Science in 1791. He