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THE DIVING "LAW-ERS" A BRIEF RESUME OF THEIR LIVES.

Chris Acott

Key Words
History, physiology.

Introduction

Early diving and diving medicine researchers were not necessarily involved with diving, some were mathematicians, philosophers, scientists and astronomers while others were physiologists and medical clinicians. Hence the history of diving and diving medicine has involved many seemingly unrelated disciplines. However, many of the researchers lives and research work were intertwined. As an example, John Dalton, an astronomer, after whom Dalton's Law was named, first published on colour blindness (which is why it was originally called 'Daltonism'). The genetics of this disorder were first studied by J B S Haldane (the son of J S Haldane). JBS Haldane was involved with both the Royal Navy Admiralty's Deep Diving Units (the first with his father and the second with L Hill, R Davis and K Donald). J S Haldane designed the first "safe" decompression tables.

A menagerie of animals, divers, "volunteers" and self experimentation were used by the early diving medicine researchers. Boyle used a viper; Bert used birds, dogs, cats and many other animals; J S Haldane used goats; L Hill used frogs but was also involved in self experimentation; K Donald used naval divers and other "volunteers". Much of the actual original diving/diving medicine research demonstrated ingenuity, lateral thinking and unique observation skills.

Unfortunately, many of the original documents are impossible to find and reliance is therefore on second hand interpretation.

This paper is a brief outline of the lives of the originators of the physical laws of diving (Archimedes and Pascal's Principles; Poiseuille and Laplace's equations; the Laws of Boyle, Henry and Dalton).

Archimedes (287-212 BC)

Archimedes was the pre-eminent Greek mathematician and inventor, who wrote important works on plane and solid geometry, arithmetic and mechanics. He was born in Syracuse, Sicily (the exact date is not known, however, popular belief has it as 287 BC) and was educated in Alexandria, Egypt. In pure mathematics he anticipated many of the discoveries of modern science, such as the

integral calculus. He published his works in the form of correspondence with the principal mathematicians of his time. He spent the majority of his life in Sicily, in and around Syracuse. He did not hold any public office but devoted his entire lifetime to research and experiment. During the Roman conquest of Sicily several of his mechanical devices were used in the defence of Syracuse (the catapult and the legendary mirror system for focusing the sun's rays on the invading boats and igniting them). After the capture of Syracuse during the second Punic Wars, Archimedes was killed by a Roman soldier who found him drawing a mathematical diagram in the sand. It is said that Archimedes offended the soldier by being so absorbed in his work that he remarked to the soldier, "Do not disturb my diagrams."

He is credited with the invention of the pulley and the hydraulic screw for raising water. However, he is best known for his discovery of the law of hydrostatics, often called **Archimedes Principle**, which states that a body immersed in fluid loses weight equal to the weight of the amount of fluid it displaces. The story that he ran naked through the streets of Syracuse shouting "Eureka" ("I have found it") is a popular embellishment.

Several of his works on mathematics and mechanics survive, including "Floating Bodies, The Sand Reckoner, Measurements of the Circle, Spirals" and "Sphere and Cylinder".

Jean-Louis-Marie Poiseuille (1799-1869)

Poiseuille, a French physiologist and physician, was born in Paris on the 22nd April, 1799 and died in Paris on the 26th December, 1869. He received his medical degree in 1828. His interest in the circulation of blood led him to conduct a series of experiments on the flow of liquids in narrow circular tubes. He formulated the mathematical expression for non-turbulent (laminar) flow of fluids in 1839. This equation is known as the Hagen-Poiseuille equation, because it was also described independently by a German hydraulic engineer, Gotthilf Heinrich Ludwig Hagen in 1840.

Blaise Pascal (1623-1662)

Pascal was born on 19th June, 1623 at Clermont-Ferrand, France and died on the 19th August 1662. A mathematician, physicist, religious philosopher and master of French prose who laid the foundation for the modern theory of probabilities. He formulated **Pascal's Principle** of pressure (probably about 1654).

In 1644 he conceived and constructed the first digital calculator to assist his father in his work as a Tax administrator. He laid the foundations for the calculus of probabilities.

He invented the syringe and constructed a hydraulic press. His work with the mercury barometer confirmed the experimental work of Torricelli.

His two major religious works were "Les Provinciales" (1657) and "Pensees" (1670).

He died a painful death from meningeal carcinomatous secondaries from a gastric carcinoma.

Robert Boyle (1627-1691)

Boyle was born in Lismore, Ireland. He was the 14th child of rich, influential parents. He was educated at home by private tutors, at Eton (1635-38) and in Geneva (1639-1644). A devout Protestant, who throughout his life was an earnest student of theology, he was interested in missionary work and subscribed to societies which were for the propagation of the Gospel.

In 1644 he returned to England after he inherited his father's manor of Stalbridge, Dorset. In 1645 his interest in science was influenced by the Philosophical College (which later became the Royal Society) and, until he visited Ireland in 1652, he specialised in chemistry. During his stay in Ireland (1652-53) he studied anatomy.

In 1654 he settled in Oxford and erected a small laboratory. At this time he was the leader of a small scientific society. About 1659, assisted by Robert Hooke, he invented the "machina Boyleana" which was the forerunner of the modern air-pump.

His achievements were numerous. He recognised the differences between compound and mixtures, acids, bases and salts. He introduced colour testing for acidity and alkalinity. He formulated the Atomic Theory which challenged the Aristotelian concept of the four elements. His book "The Skeptical Chymist" was the foundation of modern chemistry and he is often referred to as the "Father of modern chemistry". His experiments with air showed that air was necessary for combustion, respiration and sound transmission. He was the first to isolate and collect gases. He was one of the founding members of the Royal Society of London. He was the originator of the "experimental method". His work influenced many others including Newton and Jonathan Swift.

In 1662 Boyle's Law was published. He showed that a reduction in pressure caused bubbles in tissues. His description of the viper with the bubble in its eye was the first of an animal with decompression sickness. He described the cause of decompression sickness as: "The little bubbles...by choking up some passages, vitiating the figure of others, disturbe or hinder the due circulation of blood." This was ignored until the work of Paul Bert.

Pierre-Simon Laplace (1749-1827)

Born on the 23 March, 1749, in Beaumont-en-Auge, Normandy he died in Paris on 5 March, 1827. He was a mathematician, astronomer and physicist who is best known for his investigations into the solar system.

He was the son of a peasant farmer. Little is known of his early life except that he was educated at a military school in Beaumont. He did not have strong political views and so escaped execution during the French revolution, not so his friend A Lavoisier.

In 1780 with the help of Lavoisier he showed that respiration was a form of combustion. His scientific work laid the foundations for the study of heat, magnetism and electricity. In 1796 he published "The System of the World" ("Exposition du systeme du monde") which strongly influenced future thought on the origin of the solar system. In 1814 he described the mathematical model for the prediction of probabilities that a particular event will occur in nature. He also aided in the organisation of the metric system and help found the Society of Arcueil, a French scientific society. He was created a Marquis for his scientific work.

John Dalton (1766-1844)

Born on the 6th September 1766 in Eagesfield, England and died in Manchester on the 27th July 1844. He was the son of a Quaker weaver and received his early education from his father. He retained his Quaker faith throughout his life. He was a recluse with few friends and dedicated his life to scientific research. He never married.

His scientific life began in 1787. He is known as one of the fathers of modern physical science. His homemade equipment was crude and his data and record keeping were not exact, hence the dates for some of his work are unknown. His early studies on gases led to the publication of his gas laws in 1801 (his first law is now known as Charles' Law and his second was the law of partial pressures and is now known as Dalton's Law).

Dalton began a series of meteorological observations in 1787 that he continued for 57 years. His interest in meteorology led him to study a variety of phenomena as well as the instruments to measure them. He was the first to prove that rain was due to a decrease in temperature and not a change in atmospheric pressure.

He suffered from colour blindness and published, in 1794, the first scientific paper on it called the "Extraordinary facts relating to the vision of colours". He attributed colour blindness to a discolouration of the eye's aqueous humour. Colour blindness was known as Daltonism for many years.

Dalton's most important contribution to science was that matter is composed of atoms. In 1804 he published his table of atomic weights. He also proposed the "Law of definite proportions" and the composition of ether.

He was a Fellow of the Royal Society, from whom he received a gold medal in 1826 and was also a co-founder of the British Association for the Advancement of Science.

Unfortunately all his documents were destroyed during the bombing of London in World War II (the Blitz).

William Henry (1775-1836)

Henry was born on 12th December 1775 and suicided on the 2nd September 1836. As a chemist he studied hydrocarbon gases and is best known for the discovery of the solubility of gases. Henry's Law was published in 1803.

In 1807 he graduated from the Edinburgh Medical School. Ill health forced him to retire from medical practice. He was made a Fellow of the Royal Society in 1808.

Jacques-Alexander Charles (1746-1823)

Charles was born on Beaugency, France, in 1746 and died in Paris in 1823. A mathematician, physicist and inventor he was the first to ascend in a hydrogen balloon in 1783. He discovered his gas law in 1787 but did not publish it until after Dalton had published it. He also invented the hydrometer and improved Fahrenheit's aerometer.

Robert Hooke (1635-1703)

Hooke was born on the Isle of Wight on 18th July 1635 and died 3rd March 1703. He was educated at the University of Oxford and is known for his study of elasticity (Hooke's Law of the spring). He made other original contributions to many other fields of science. While at Oxford he served as an assistant to Robert Boyle. He helped Boyle develop the air pump and aided him in his experiments on the properties gases. He also demonstrated that air was necessary for respiration by intubating and ventilating a dog with a set of bellows - he was the first to do so.

Hooke's Oxford friends formed the nucleus of the Royal Society in London and they appointed him curator of experiments in 1662.

Hooke's 'Micrographia' indicated the great potential of the microscope. He was the first to use the name "cell" and initiated the study of insect anatomy. He

considered fossils to be remains of organic creatures and suggested the mutability of species when fossils bear no resemblance to living creatures.

His work in orbital dynamics influenced Newton. Both corresponded with each other although there was a large degree of animosity between them. After the Great Fire of London he was appointed surveyor of London and designed many buildings including Montague House and Bethlehem Hospital.

Edmond Halley (1656-1742)

Edmund Halley was an astronomer (a comet is named after him) and mathematician. He was born in Shoreditch on the 8th November, 1656 and died in Greenwich on the 14th January, 1742.

In 1684 he met Sir Isaac Newton. He was one of Newton's major supporters. He funded and published Newton's 'Principia' in 1687. He was a Fellow of the Royal Society at the time of Hooke, Boyle and Wren.

In 1686 he published the first world map showing prevailing winds over the oceans. In 1701 he published the first magnetic charts of the Pacific and Atlantic oceans.

In 1690 he designed his first diving bell, which had an atmospheric air supply. He subsequently improved this design in 1716. The air supply was replenished by 2 thirty six gallon barrels lowered below the bell and connected to the bell by a hose. Divers used this bell to depths of 18 m and apparently stayed submerged for up to 1.5 hours with no recorded cases of decompression sickness.

He developed life expectancy charts in 1693 which were the first attempt to relate mortality and a population's age. These charts were used for insurance purposes (the first modern life insurance policy was issued in England in 1583) and are still the basic model used by Insurance companies today.

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DIVING BELLS THROUGH THE CENTURIES

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Key Words

Bell diving, equipment, history.

Abstract

One of the oldest, successful and most enduring forms of diving involves the use of a diving bell. This paper traces the history of the applications and development of the diving bell over a period in excess of 2,000 years. Setting off in pre-Christian times in the Middle East, the story travels all over Europe, with occasional expeditions to the Americas, and closes with the appearance of the modern "transfer under pressure" bell, first introduced by the Royal Navy and now universally adopted.

Introduction

Alexander the Great is credited with the first recorded bell dive in 332 BC.[1] Legend has it that he descended in a bell called "Colimpha" at the Siege of Tyre. Aristotle described how his pupil, Alexander the Great, peered out of his bell to observe underwater sheep and dogs and even one gigantic creature that took three days to pass by! But before we credit Alexander the Great with being the first saturation diver as well, we have to consider that his bell was probably an atmospheric observation bell since it was referred to as a glass case, covered with asses skins and provided with a door made fast with chains. Another version describes the bell as constructed of wood, fitted with glass windows and a lid impregnated with resin, wax and other substances to make it water tight. Whilst the accuracy of any of the accounts is questionable, it may at least be reasonable to presume that Alexander the Great made some sort of a dive in some sort of a bell.

The 16th century

Surprisingly we have to wait nearly 2,000 years for the next and more reliable account of a bell dive.[2] An Italian by the name of Gulielmo di Lorena came up with a design for a bell in AD 1531. The diver had little freedom of movement because he was strapped into a frame inside the bell. The specially interesting aspect of this design is that it was a bottom-orientated bell which allowed diver to walk on the sea bed. So whilst the bell was raised and lowered by a lifting rope to the surface, it had the important ability to move laterally over the sea bed. In 1535 Francesco da Marchi dived in Lorena's bell and claimed to have remained underwater for one hour surveying Caligula's pleasure galleys sunk in lake Nemi near Rome but no mention is made of how the air was replenished within the