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The physiologist who discovered the role of low blood oxygen at high altitude

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Nowadays, it's well accepted that the cause for altitude sickness—the host of symptoms including headache, fatigue, digestive problems, dizziness, and sleep disorders that occurs when climbers ascend a tall peak too quickly—is low levels of oxygen in the blood. However, before the mid-1860s, altitude sickness was still a mystery. A French researcher named Paul Bert is often hailed as the father of low altitude physiology for publishing an influential book in 1878 on the sometimes-harmful effects of high altitude, attributing them to what's now known as hypoxia. However, often lost in this history is that hypoxia was first identified as the altitude sickness' root years earlier by French physician Denis Jourdanet.

In a new article, John B. West of the University of California-San Diego and Jean-Paul Richalet of Université Paris, review the history behind Jourdanet and his large body of work connecting the health effects of altitude with the level of oxygen in blood. Jourdanet, who later served as Bert's generous research benefactor—and whom Bert acknowledges in his own work as the real source of the hypoxia theory—was a prolific researcher with a wide-ranging body of work. He connected the symptoms of altitude sickness with similar symptoms caused by anemia, in which blood oxygen is low because of a decreased number of red blood cells. He also studied the relationship between barometric pressure and altitude, physical differences present in populations who live at high altitudes compared to those at sea level, and the possibility of different atmospheric pressures to treat some diseases.

The Review article, titled "Denis Jourdanet (1815-1892) and the Early Recognition of the Role of Hypoxia at High Altitude," appears in the online edition of the *American Journal of Physiology*: Lung Cellular and Molecular Physiology, a journal published by the American Physiological Society. It is available at bit.ly/175qrWL.

Higher altitude for health?

West and Richalet write that Jourdanet was not yet finished with medical school in France when, at the age of 26, he decided to seek his fortune in Mexico. Living in the Yucatan Peninsula, he set up an unauthorized clinic. However, impressed by a cataract surgery that Jourdanet performed, the French consul legally authorized him to practice medicine.

Jourdanet worked his way into wealthy society, marrying into a well-to-do family. In 1846, he moved back to Paris with his wife to finish medical training. When the couple moved back to Mexico two years later, they decided not to live in the Yucatan Peninsula as the climate there seemed to worsen his wife's tuberculosis. Rather, they chose to live in Puebla, a town southeast of Mexico City with an altitude of 2200 meters. There, Jourdanet became fascinated with the effects of altitude on health. As his wife improved, he speculated on the value of a reduced barometric pressure in treating disease. He also took detailed measurements of barometric pressure at increasing altitudes, including at the summit of the volcano La Malinche, at an altitude of 4461 meters.

Altitude anemia

When Jourdanet's wife died in 1859, the researcher returned to Paris, where he presented his findings at a meeting of the French Academy of Medicine. He argued that residing at a high altitude could contribute to

health, but that ascending in altitude too abruptly caused sickness by reducing the amount of oxygen in the blood. He drew parallels between anemia at sea level and decreased blood oxygen at high altitudes, a concept he called anoxyhémie. His work encountered a mixed reception, with several prominent researchers arguing that conditions other than low blood oxygen cause altitude sickness.

Despite these naysayers, Jourdanet published his first book on the health effects of "rarified air" in 1862. Several years later, Jourdanet met Paul Bert, a researcher who was also interested in the health effects of high altitude. Jourdanet, who had since remarried into another wealthy family, financed an extensive laboratory for Bert to study this topic.

In the meantime, Jourdanet was busy with his own research. In 1875, he published a two-volume book about the effects of barometric pressure on human health, reemphasizing the idea that altitude sickness and anemia were both illnesses of low blood oxygen. In this book, he often referred to altitude sickness as "anémie barométrique," further cementing the connection.

Jourdanet in the spotlight

Although this idea is fully accepted today, both Jourdanet and Bert performed the critical work to firmly set its foundation. But though Bert widely acknowledged Jourdanet as the first to suggest that hypoxia causes altitude sickness, Jourdanet's role has largely disappeared from history, West and Richalet write. They suggest that this review shines the deserved spotlight on Jourdanet's work.

"Little has been written about Jourdanet," they say, "in fact this is the first article about Jourdanet's scientific work in English and his work deserves to be better known."

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