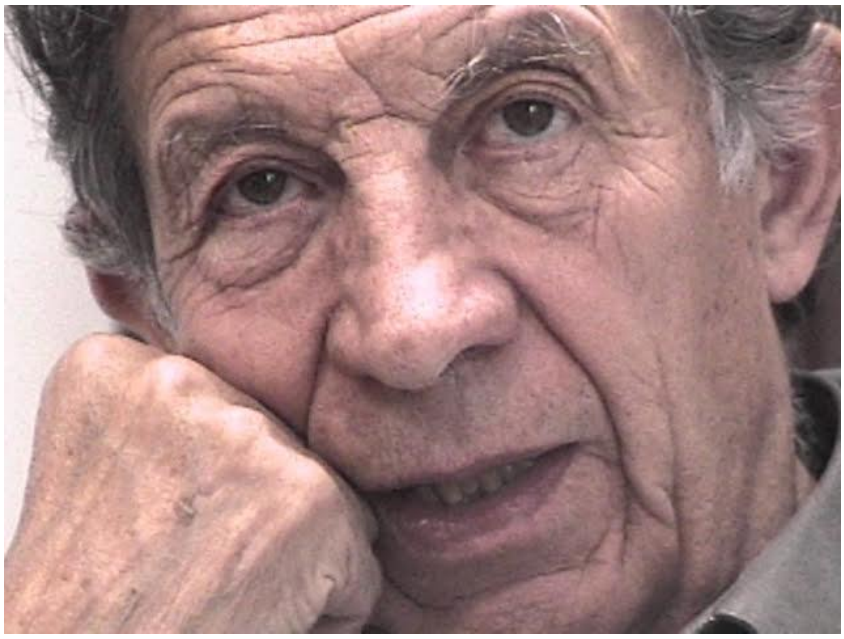
Prof. Dr. Gustavo Zubieta-Castillo's last breath in his beloved high altitude city La Paz, Bolivia (3510 m)



"Spending my 90s", as he used to affirm, **Prof. Dr. Gustavo Zubieta-Castillo**, left this physical world on September the 17th, 2015 leaving behind: everything he used, personally created, his thoughts, his questioning attitude, his severe criticism of what he considered wrong or misleading, his inquisitive mind, his courage and tenacity, his kind and generous attitude, his extraordinary teaching abilities, his visionary intelligence, his defense of life at high altitude, his poems, his captivating literary production, his oil paintings, his discipline, and even his own organism. Only the last Carbon, Potassium, Sodium, Calcium and Iron molecules he used remain. How amazing that their interaction within his neurons, gave light to so many thoughts, innovations, ideas in science, philosophy, art, and everything he left us.

This scientist and visionary, born in Oruro, Bolivia in very poor conditions, became an Academic Member of the Bolivian Academy of Sciences and the Bolivian Literature Academy correspondent of the Royal Spanish Academy, yet he remained simple and friendly. His name is currently printed in the Diccionario de la Real Academia Española (The official Spanish Dictionary).

In 1955, he began to demonstrate his curiosity for understanding life at high altitude as a young physiology professor at the State´s University "Universidad Mayor de San Andres", in La Paz (3600m). Some years later, he performed isolated heart perfusions (www.altitudeclinic.com/blog/2011/06/increased-heart-tolerance-to-hypoxia-at-high-altitude/) in dogs proving heart surgery could be successfully carried out in spite of the altitude, contrary to the common belief at the time (Fig. 1). As a result of his experiments, he affirmed that the hearts at high altitude were more resistant than those at sea level. This visionary observation is currently subject of innumerable papers on the favorable effects of hypoxic exposure on heart function (Fig. 2).

Fig. 1. On the left, Prof. Dr. Gustavo Zubieta-Castillo in his physiology laboratory. Note the kymograph with smocked paper and the isolated heart in the central area.

CON EXITO SE REALIZO UNA DEMOSTRACION CIENTIFICA EN EL INSTITUTO DE FISIOLOGIA DE LA FACULTAD DE MEDICINA DE LA UNIVERSIDAD MAYOR DE SAN ANDRES

Agregó el Dr. Subieta que por las observaciones que él viene haciendo, los corazones de las personas habituadas a la altura son mucho más resistentes a la anoxemia es decir a la falta de oxigeno con relación de los corazones habituados a la costa.

Dr. Zubieta added that according to the observations he has been making, the hearts of high altitude residents are much more resistant to hypoxia, the lack of oxygen, than sea level residents.

Fig. 2. The article "A scientific demostration was successfully carried out at the Physiology Institute, Faculty of Medicine, Universidad Mayor de San Andrés" was published in the newspaper "Última hora" in 1964.

In memoriam: Prof. Dr. Gustavo Zubieta-Castillo

On July the 9th, 1970, Prof. Dr. Gustavo Zubieta-Castillo founded the first High Altitude Clinic (Instituto Privado de Patologia en la Altura - IPPA, www.altitudeclinic.com/) in the world. This Institution built in the city of La Paz at 3510m, was dedicated to research, diagnosis and treatment of disease at high altitude. Multiple research projects were performed using personal funds obtained from patient care. One of them was the construction of the "Hyperoxic / Hypoxic Adaptation Chamber" (www.altitudeclinic.com/hhac.html) designed to modify the inspired oxygen tension, simulating different altitudes ranging from sea level to the summit of Mount Everest. This is the first one created at high altitude in the world. Later, in 1989, we wrote the first book published in English in Bolivia called "High Altitude Pathology at 12000 ft". It was dedicated to: "Those of short breath at high altitude".

The First High Altitude Pathology Course of the world was carried out by him and the IPPA team in La Paz, Bolivia, in 1992. Further on, he, Gustavo Jr and the physician of the American Embassy co-organized the First World Congress on High Altitude Medicine and Physiology (www.altitudeclinic.com/congress.html) that started in La Paz in 1994, and moved on to Cusco–Perú, Matsumoto- Japan, Arica-Chile, Barcelona-Spain, Xining-China & Lhasa-Tibet as well as many other cities – countries that we lost track of.

In 2002, we created the "Science, Honor and Truth" (www.altitudeclinic.com/award.html) award with a medal which says "defeating hypoxia". The most distinguished scientists that truly follow these forgotten concepts are awarded every two years.

Fig. 3. The Science, Honor and Truth Medal.

Three years later, we initiated the Symposium: The Effect of Chronic Hypoxia on Diseases at High Altitude (http://zuniv.net/symposium), held every two years. In the course of the II Chronic Hypoxia Symposium, the International Society of Chronic Hypoxia (ISCH) was founded with several attending colleagues. The IV International Conference in Chronic Hypoxia was carried through in Delhi, India, jointly with the Global Hypoxia Summit. The last one in his life was the V Chronic Hypoxia Symposium in 2014. The Wilderness and Environmental Medicine Journal published our abstracts, for which we are most profoundly grateful.

Upon arrival to La Paz, from every sea level trip, in spite of the fatigue, he would insist that tests be performed on ourselves in order to observe any changes during adaptation. This gave rise to the paper "Adaptation to high altitude through hematocrit changes" and our development of the High Altitude Adaptation Formula:

$$\text{Adaptation to high altitude} = \frac{time}{altitude}$$

Following the concept of the Hyperoxic/Hypoxic Adaptation Chamber, in our laboratory in La Paz, the Chacaltaya Pyramid Laboratory (www.altitudeclinic.com/pyramid1.html), the highest in the world, located at 5300m reachable in one and a half hours by road, was built by the IPPA Team under his leadership. He insisted that it follow the proportions of the Giza Pyramid in Egypt and that one of the sides, face the North. Unbelievably, when we inspected the site searching a place to put it, an empty stone platform of the same size and facing the right direction, was found.

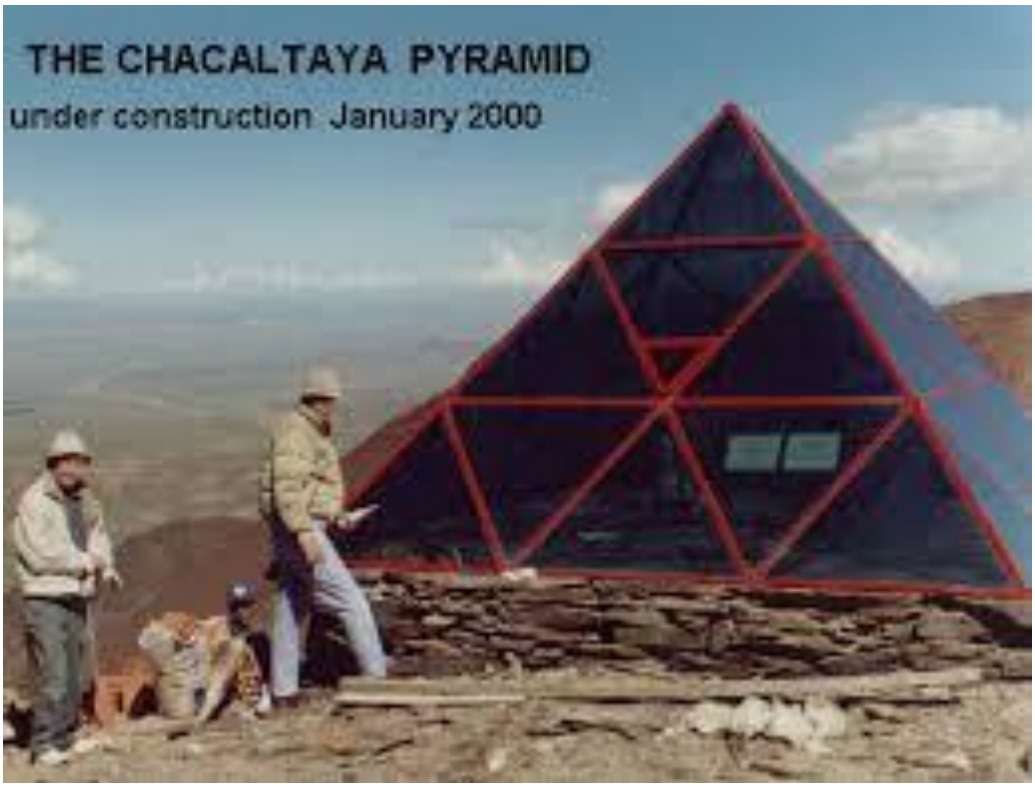


Fig. 4. Gustavo Zubieta-Castillo (Sr) on the left and Gustavo Zubieta-Calleja on the right.

The following year, he led the unequaled highest soccer (football) game played on the summit of Mount Sajama (www.altitudeclinic.com/sajama1.html), the highest mountain in Bolivia at 6542 m, proving that sports at that high altitude are possible. With this event, the extraordinary physiological capacity of the Andean population (bolivian Aymara descendents) was exposed thereby defending Bolivia to play the World Cup in its own fields in La Paz (3600m). Many wanted to claim authorship, but he was the true accomplisher as shown by several publications, interviews, like the BBC.

Fig. 5. The historic football game played on the Summit of Mount Sajama (6542m) on July the 7th, 2001.

His original and unique perspective on what was previously called "Chronic Mountain Sickness" (http://altitudeclinic.com/blog/2010/07/chronic-mountain-sickness-discussion-part-1/), a term he proposed should be discarded and substituted for "PolyErythroCythemia" (a precise word describing the clinical sign of the increase of the number of red blood cells resulting from multiple pathologies in the hypoxic environment at high altitude, instead of considering it a disease), changed the view of many scientists around the globe. This was a subject of controversy but of his absolute conviction, based on his over 50 years of medical practice, life and research at high altitude. Throughout his existence, he opposed the obsolete concept of reducing the number of red blood cells with archaic treatments such as phlebotomy or the use of toxic drugs such as Phenylhydrazine, an OMS proscribed drug. Thereby, he interrupted its use saving thousands of Polycythemia patients from a guaranteed fatal outcome. He often considered this his most outstanding feat.

Another creation of his, is the description to explain the temporary and reversible decrease of PaO2 in Polyerythrocythemic patients, which he called "The Triple Hypoxia Syndrome" (www.altitudeclinic.com/thsart.htm). This essential diagnosis based on the understanding of high altitude pathology consists of three superimposed hypoxias: the environmental high altitude hypobaric hypoxia + the hypoxia resulting from chronic cardiopulmonary diseases fundamentally or others that may further reduce the PaO2 (as would typically happen at sea level) + an additional decrease of the PaO2 due to acute and transitory diseases such as a severe cold, pneumonia, pulmonary thromboembolism, etc. This occurs because at high altitude, the low PaO2 is located on the steep part of the oxygen dissociation curve.

One of the most revolutionary positions in the history of high altitude medicine was his firm opposition to the use of the term "loss of adaptation" (http://altitudeclinic.com/blog/2010/07/forever-loss-of-adaptation-does-not-exist/) in polyerythrocytemia (or Chronic Mountain Sickness). He emphatically and strongly affirmed: "there is no loss of adaptation!!". Consequently he wrote:

"*The organic systems of human beings and all other species tend to adapt to any environmental change and circumstance within an optimal period of time, and never tend towards regression (loss of adaptation) which would inevitably lead to death".*

In fact we had a dissenting point of view (http://altitudeclinic.com/blog/2010/07/chronic-mountain-sickness-discussion-part-1/) in the International Consensus for the Definition of High Altitude Diseases (http://online.liebertpub.com/doi/pdf/10.1089/ham.2005.6.147) that eventually stopped the use of the term "loss of adaptation".

His words are embossed next to his ashes in the middle of his memorial at the High Altitude Museum (the first in the world) founded, directed by his granddaughter Natalia Zubieta-DeUrioste

and under development in the current IPPA building.

In 2003, following the observation of: A) the low levels of PaO2 in patients with polyerythrocythemia at high altitude, B) the soccer game on Mount Sajama (6542m), C) a Rugby player that suffered high altitude pulmonary edema and tolerated a PaO2 of 27 mmHg for several days fully recovering in the end, D) the fetal PaO2, and E) the Triple Hypoxia Syndrome, among others, he formulated the theory that *man can adapt to live at the summit of Mount Everest*. The explanation of this was launched as a talk recorded in a video presented at The Astroeco Conference in Terskol, Russia by invitation of Dr. Pavel Beloshitsky. The abstract was published in the Conference Abstracts, and the first full paper entitled "Adaptation to life at the altitude of the summit of Everest", was published in the Fiziol Zh. 2003; 49(3):110-7, by suggestion of Dr. Tatiana Serebrovskaya of the Bogomoletz Institute in Kiev. This famous institute was visited by us, where we enjoyed the meetings with the Ukranian colleagues (Fig. 6).

Fig. 6. At the Bogomoletz Institute in Kiev, Ukraine. From left to right: Gustavo Zubieta-Castillo Sr., Pavel Beloshistky, Platon Kostyuk, Sei-Itsu Murota (Tokyo, Japan), Tatiana Serebrovskaya, Vadim Berezovskii, Zoya Serebrovskaya, Gustavo Zubieta-Calleja (Jr), Olga Harmatina. 2000.

As it happens, Gustavo (Sr) was delighted with the Russian and Ukranian cultures so he had previously started learning russian when he was 60 years old ending up in meetings four times in Moscow and one visit to Ukraine.

The visit to Dr. Vadim Berezovskii's lab was of particular interest as he was performing the hypoxic treatments of asthma and peripheral circulatory deficiencies with a Hypoxicator. He even gave us one of his helmets as a gift, currently at our Institute. In 2006, we were invited to attend the International Society for Adaptive Medicine Congress in Moscow, Russia. A new version entitled "Facts that prove that Adaptation to Life at Extreme Altitude (8848m) is Possible" was published in the book "Adaptation Biology and Medicine" Volume 5 edited by Lukyanova, Takeda and Singal.

His last conference on this subject was given this February 2015 at the Congreso Internacional de Medicina de Altura (CIMA) in Puno, Perú in a joint effort of the Peruvian and Bolivian Medical Colleges. There, he was awarded several distinctions. Thank you to all those that recognized his talents.

But, Prof. Dr. Gustavo Zubieta-Castillo not only dedicated his life to science, but just as well

to literature and art, among other things. He wrote a unique article entitled "The mathematics in the structure of Literature", showing how Miguel De Cervantes description of Don Quijote and Sancho Panza were extremes in a Gauss curve (Fig. 7).

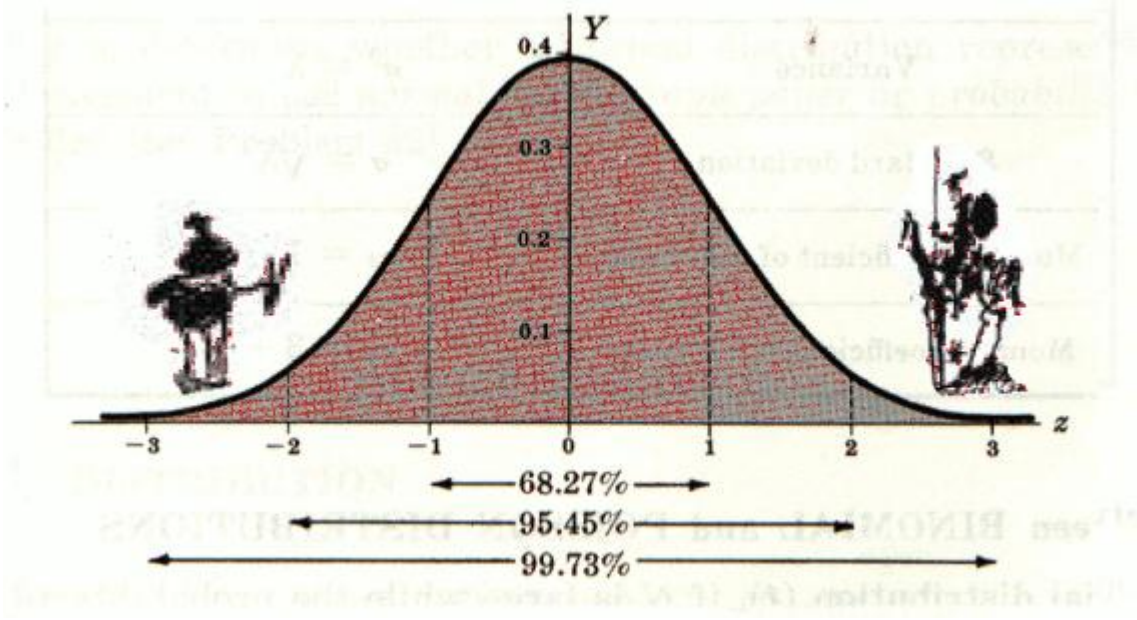


Fig. 7. His mathematical interpretation of the instinctive use of the normal distribution of Gauss in Don Quijote de la Mancha and his assistant Sancho Panza, by Miguel de Cervantes Saavedra.

All along his life he wrote four books ("Relatos, sueños y realidades", "Memorias gratas e ingratas de la práctica médica", "Una entrevista con Mr. Sherlock Holmes","Pensamientos libres") and several essays published in press. His book titled "Memorias gratas e ingratas de la práctica médica" (Pleasant and Unpleasant memories of the medical practice) represents his autobiography regarding medical practice. A newspaper he founded was called "El Zodiaco" (the Zodiac) and since he was the author of the majority of its content, he named the editor "Gus Littlebridge" (note that his last name "Zubieta" is Basque and it means little bridge). Other writings of his are short stories delightful to read in Spanish resulting from his creative imagination.

Similarly, he painted tens of oil paintings (www.altitudeclinic.com/art.zuniv.net/photo_album.0.html) that express his love for beauty found in simple things of his everyday life. The diverse subjects of these include flower and fruit arrangements, landscapes, the life of the bolivian indigenous people (selling, dancing, etc), the houses where he lived, some personal copies of well-known paintings such as "Moulin de la Galette" de Renoir, among others. In fact, he wrote an article about the meaning of Beauty, and another one about Gratitude (his last one, http://altitudeclinic.com/blog/2014/12/gratitude/).

Finally, although there is much more, in November 11th, 2009, under the generous sponsorship of Dr. Thuppil Venkatesh, "the Lead Man of India" at the Saint John's University in Bangalore, he was honored with the unique distinction of "Parvatha Guru" (The Mountain Guru, http://altitudeclinic.com/blog/2010/01/the-mountain-guru/). The word "guru" was used in several ways throughout history. It means "spiritual master", gu = "ignorance" - ru = "the one who dissipates", "knowledge imparter", "wise", and others, being the nowadays interpretation "professor, guide or master of a certain profession", in other words "the expert on something". It is an equivalent of the Honoris Causa.

Fig. 8. Gustavo Zubieta-Castillo, sitted, during the ceremony of his award as the Mountain Guru, in Bangalore, India.

Our research and publications, never received one sole grant (being them nonexistent in Bolivia). All the accumulated knowledge became our contribution to the well-being of the residents of high altitude. In order to carry out such feats, we constructed our own equipment (based on extensive intellectual knowhow including the fields of mathematics, physics, chemistry, mechanics, electronics, computer studies, biochemistry, hydraulics, etc), writing our own software (mainly by Gustavo Jr.), due to the fact that the medical and experimental equipment used needed to be calibrated for high altitude. For the purpose of studying life at high altitude we gave all our time and effort with satisfaction thereby having "the Joy of seeing the light" as our dear friend and outstanding Danish physiologist Poul-Erik Paulev affirmed. We jointly created the Poul-Erik High Altitude Diving Laboratory in his honor and we developed high altitude diving tables.

His publications are cited in many papers around the globe and have recently shot up in the number of downloads and views available at ResearchGate.net. See part of his lifetime achievements at: http://altitudeclinic.com/blog

Conclusively, Prof. Dr. Gustavo Zubieta-Castillo had the absolute certainty that after he left, he would receive recognition for his work and for his theories of which he never doubted. It is left to be seen if he was right!

P.D. Thank you father, mentor, professor, wise mountain Guru for having left us a legacy, and a school of thought that Natalia, Rafaela, (my two daughters), Lucrecia (my wife), Nancy, Luis and Rosayda (my brother and sisters), Clotilde (my mother, his attentive and unconditional supporter and lifetime companion), Gustavo, Katia, Luis Andres, Sebastian, Joyce and Andrei, (his other grandchildren) and even his first grandson Thomas Andrew Jenkins will spread and continue, once they discover him…

Prof. Dr. Gustavo Zubieta-Calleja & Natalia Zubieta-DeUrioste

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