tion of carbon in the deep sea at the expense of the surface ocean and atmosphere. The papers in this collection are in general agreement that the sudden rise in atmospheric carbon dioxide at the end of the ice age was caused by a reduction in the effectiveness of this biological pump. General theoretical analyses in three papers show how a change in biological activity can lead to a transfer of carbon out of the deep sea and an increase in the atmospheric partial pressure. But there is no agreement on the processes responsible for the change in biological activity. Three competing hypotheses are presented and developed in some detail. An interesting prediction of the theories, not yet confirmed by observation, is that the oxygen content of the deep sea decreased significantly during the ice age as a result of increased respiration of settling organic particles.

Many papers in this collection are devoted to the search for further diagnostic observations that might distinguish between the competing theories. Measurements of the isotopic composition of carbon in sea floor sediments show promise, as do observations that reveal periods of dissolution of carbonate minerals. The book makes it clear that this field of research is developing rapidly, both observationally and theoretically.

The evidence for longer-term changes in atmospheric carbon dioxide is by no means as clear, but the case is becoming stronger. One hundred million years ago, during the Cretaceous Period, the earth apparently enjoyed a warmer climate with much less contrast between tropical and polar temperatures. Two papers in the collection are devoted to theoretical efforts to explain the change in climate since then. These papers explore the potential impact of various aspects of the climate system and agree in assigning an important role to a presumed higher partial pressure of carbon dioxide in the atmosphere. Increased partial pressure of carbon dioxide increases the surface temperature by reducing the rate at which the globe cools to space by emission of infrared radiation. Observational evidence for high carbon dioxide partial pressures at this time is provided by the isotopic composition of sediments and by carbonate mineralogy, but the way in which these records should be interpreted is by no means clear. Theoretical studies indicate that high carbon dioxide during the Cretaceous could be a consequence of an enhanced rate of release of carbon dioxide from volcanic and metamorphic activity and a reduced rate of consumption of carbon dioxide in the chemical weathering of continents at a time when sea level was high and the quantity of land exposed relatively small.

Other papers present observations and theory that relate to atmospheric carbon dioxide at times extending back to the Archean Era of earth history, more than 2.5×10^9 years ago. Though the history is now known only in broad outline, this collection makes it clear that atmospheric carbon dioxide has fluctuated naturally on all geological time scales. The record is being read with increasing confidence. The climatic, geochemical, and biological impacts of these fluctuations are being evaluated. The excitement of this new area of research is captured by this volume, which also brings the reader nearly up to date. Research on the carbon cycle and its natural variations in the past will make our predictions of the future impact of fossil fuel burning and deforestation much more secure.

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The Adoption of Anesthesia

A Calculus of Suffering. Pain, Professionalism, and Anesthesia in Nineteenth-Century America. MARTIN S. PERNICK. Columbia University Press, New York, 1985. xvi, 421 pp., illus. $35.

Traditional histories of medicine have focused on scientific discoverers and their discoveries; they make heroes of the discoverers and interpret the innovations as contributions to the unfolding of science and reason in Western society.

Within the last decade a new generation of medical historians has moved in significant new directions. Rather than glorifying a few leading figures in the scientific-medical community these new historians have expanded their focus to look at physicians within the broader boundaries of American society. In doing so, they have introduced variables such as class, race, and gender into their analyses and have interpreted medical events, doctors, and the medical profession within the context of American culture.

Martin S. Pernick's *A Calculus of Suffering* is a welcome addition to the new medical history. While it focuses on a major medical innovation—the introduction of anesthesia in surgery—this study moves well beyond the history of the discovery. Pernick asks how mid-19th-century physicians, the first generation to confront the option of surgery under anesthesia, integrated anesthesia into their practice. In particular, he seeks to explain how they decided who should receive anesthetics and who should not. He also examines broader issues such as the relationship of anesthesia to changing medical views of pain, contemporary reform movements, and the entrance of women doctors into surgery.

Pernick shows that mid-19th-century physicians did not hail the discovery of anesthesia as a major scientific triumph. Instead, they responded to it cautiously, sometimes quite critically, and their reactions depended as much on social and cultural factors as they did on medical thought.

Physicians' ideas about pain influenced their responses to anesthesia. Pernick shows that homeopaths, hydropaths, and other advocates of the healing power of nature defined health as natural and pain as unnatural, indeed as punishment for unhealthy living. Rejecting surgery as artificial and intrusive, they rejected anesthesia for the same reason, advocating instead a regimen of diet, exercise, and natural living that they believed would promote health and prevent disease and pain.

The natural healers who shunned all artificial attempts to prevent pain stood at one end of the medical spectrum. At the other end were the heroic physicians, those who bled, blistered, and drugged their patients. They believed that pain was natural and often a necessary part of the healing process. Their belief in the curative component of pain thus led heroic physicians to essentially the same conclusion as the natural healers, the rejection of anesthesia. In cases where heroic doctors defined pain as a disease in itself, however, anesthesia became an appropriate therapy. Pernick makes the irony clear. In such a case, a patient in pain would encounter a harsher response from the natural healers, who advocated mild therapeutics, than she or he would from the heroic physicians, who would respond sympathetically to the disease of pain and might treat it medically with surgery under anesthesia.

Midway between the natural healers and the heroic physicians stood the advocates of "conservative medicine." Conservative physicians, according to Pernick, adopted a utilitarian approach to anesthesia, using it when they believed it offered the best route to cure and rejecting it in other cases. Pernick argues that with this alternative approach of conservative physicians utility, relativism, and individualism became

the new standards for judging the value of anesthesia and replaced the more ideological and universalistic approaches of natural and heroic doctors.

According to Pernick, the conservative physicians viewed patients through the lens of individualism. Since patients had different pain thresholds, conservative physicians tailored their use of anesthetics to the needs of individual patients. Women, for example, were supposedly more sensitive to pain than men and therefore needed anesthesia in surgery more often. Blacks and Indians supposedly had a higher pain threshold than whites and could endure surgery without the relief of anesthesia. Similarly, wealthy, educated, native-born Americans could endure less pain than poor, uneducated immigrants. Hidden behind the apparent rationality and moderation of conservative physicians' approach to pain and anesthesia were a host of value judgments about women, children, blacks, Indians, immigrants, and the poor. This should not be surprising since the conservative physicians Pernick studies were typically white, American-born, highly educated wealthy men from Eastern cities. In reality, these privileged physicians' approach to pain was as much an expression of their elitism as it was of the individualism or diversity Pernick identifies. Moreover, this elitist approach to pain reflected the moralism of Victorian-American culture as much as it did the utilitarianism of the era.

One of the strengths of *A Calculus of Suffering* is that it includes women physicians in its analysis. Most medical histories have ignored women, and in the past decade a separate historiography of women physicians has emerged. Pernick begins to take the next step by integrating women into the mainstream of medical history. He argues that the advent of anesthesia promoted the entry of women into surgical practice because anesthesia made surgery less brutal, more refined, and therefore less shocking to feminine sensibilities. But what primarily enabled women to become physicians, and later surgeons, was the availability of medical institutions that would train them. For most 19th-century women physicians this meant the separate women's medical schools and hospitals founded because male-run medical institutions were closed to them. At the same time that 19th-century women physicians professed moral superiority based on their womanhood, in their daily practice they strove for professional equality with men, practicing essentially the same conservative medicine as their male colleagues. Though the discovery of anesthesia may have permitted women to preserve their feminine sensibilities as surgeons, their quest for professional equality with male doctors and pursuit of the highest professional standards were the more enduring reasons for their becoming surgeons.

In the final analysis, *A Calculus of Suffering* is an ambitious and provocative book. It will provide stimulating reading to historians, physicians, and anyone seeking to understand the relationship between medicine and society in American history.

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Pierre Duhem

Uneasy Genius. The Life and Work of Pierre Duhem. STANLEY L. JAKI. Nijhoff, The Hague, 1984 (U.S. distributor, Kluwer, Hingham, Mass.). xii, 472 pp., illus. $65.50. International Archives of the History of Ideas, 100.

Most writers of biography have strong feelings about the subject of their work. Stanley Jaki, professor of physics at Seton Hall University, is no exception. His biography of the physicist, philosopher, and historian of science Pierre Duhem (1861–1916) is a tendentious and empathetic work in which he takes up the cudgels for Duhem against both Duhem's old enemies and alleged new adversaries. Unfortunately, Jaki's crusade leads him into claims and generalizations that often are misleading and unreliable, including the theme that Duhem has been given scant attention. In making this claim, Jaki himself ignores some important literature of the last ten years, including publications by Niall Martin. Still, the biography remains a book to be read because of its detailed and accurate chronology of Duhem's life and publications and its factual portrayal of French scientific institutions with which Duhem was associated. In addition, the book provides character sketches of Duhem that demonstrate the personal traits that combined with well-known ideological factors to block his road to a prestigious chair in Paris.

Many writers on French science have remarked the anticlerical and republican milieu that made it difficult, if not impossible, for conservative and devout Catholic scientists like Duhem to make headway in French educational institutions during the early Third Republic. Duhem was royalist in his political sentiments and a supporter of the antirepublican and anti-Semitic movement associated with Action Française. Though Jaki lamely apologizes for the anti-Semitism, he shares Duhem's hostile attitude toward the secularizing leaders of the Third Republic, among them Marcellin Berthelot, whom Jaki describes indulging in extravagant restaurant dinners while other Parisians starved during the Prussian siege of 1870. (We are told that Duhem threatened his small daughter with a photograph of Berthelot when she was naughty.) When Duhem's nephew became secretary to Léon Bourgeois, president of the French senate and a republican anticlerical, Duhem wrote a letter renouncing family relations with the young man. Asked by George Sarton to collaborate in the founding of the history of science journal *Isis*, Duhem declined once he learned of Sarton's association with Freemasonry.

These and other anecdotes add up to a portrait of Duhem as a man of arrogance, "cool passion" (p. 87), imprudence, and sarcasm, who amused his friends by mimicking others and enraged his colleagues by taking uncompromising positions in disputes. Jaki concedes that there was a "touch of pride" in Duhem's character, otherwise "splendid like a shining armor" (p. 173). Jaki attributes Duhem's motivations in physics, philosophy, and history, as in politics, to an integrity that required standing up for the truth. Yet Jaki never hints that those opposing Duhem in such matters might have had similar motivation. Rather, Jaki focuses on personal ambition for advancement in the French educational hierarchy as the probable motivation inspiring those who criticized or ignored Duhem's work, an explanation that most clearly will not work for those who were not French.

Educated at the Catholic Collège Stanislas and the Ecole Normale Supérieure, Duhem taught physics initially in Lille and Rennes. He held the first chair of theoretical physics in France, created for him at the University of Bordeaux in 1895. He trained doctoral-level students and wrote prodigiously in thermodynamics and physical chemistry, with his name later becoming attached to some fundamental relations (the Duhem-Margules equation and the Gibbs-Duhem equation). A staunch antimechanist and antiatomist, he opposed Maxwell's electromagnetic theory and the "modern physics" associated in France with Paul Painlevé, Jean Perrin, Paul Langevin, and the Curies. Duhem often has been identified with the positivist tradition, an