

countered by 19th-century Americans in using water as a source of industrial power.

Hunter covers such diverse topics as rainfall, streamflow, topography and soil conditions, water rights, the management of water resources, patterns of industrial location, and regional variations in water supply and use. It is his analysis of waterwheel development that is of particular interest, however. Instead of jumping from traditional waterwheels directly to modern turbines, he turns to study the complex relationships between impulse and reaction wheels and the transitional part they played in the evolution of waterpower. Here he concentrates on the contribution of the Americans Calvin Wing, Zebulon Parker, and Samuel Howd to the development of turbine engineering in the 1820's and 1830's.

Hunter continues by documenting the entry of the outward-flow Fournayon turbine into America through the writings and experiments of the Philadelphia engineer Ellwood Morris and the introduction of Jonval's axial-flow turbine by the immigrant engineer Emile Geyelin. After discussing the installation of these early French wheels in the eastern United States, Hunter turns to the work of the Yankee hydraulic engineers Uriah Boyden and James Francis in New England during the 1840's and 1850's. He then moves on to the development of the American mixed-flow turbine and the emergence of turbines made to stock or standard patterns that could be adapted inexpensively to a variety of applications. He ends his book by tracing the declining use of waterpower and growing reliance on steam as a source of industrial power.

The book is constructed from a careful, detailed study and evaluation of the written sources. But there is more to the history of waterpower than can be found in the written record, for early millwrights and engineers did not take the time to record their work carefully and thoroughly on paper. To find the sort of evidence needed for detailed technological analysis of the traditional vertical waterwheels or the impulse and reaction wheels that were so important to the development of the true turbine, researchers are now turning to the artifacts themselves. Though much of the information thus obtained is still too new and too scattered to be reliable, these efforts provide valuable additions to the traditional documentation of the historian. Hunter's book, with its excellent overview of the history, economics, and sociology of 19th-century waterpower, pro-

vides industrial archeologists with a powerful conceptual framework for the evaluation of waterwheel remains that has been lacking in their studies. Moreover, it is a pleasure to read both for its easy style and for its erudition.

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Life of an Anatomist

Paul Broca. Founder of French Anthropology, Explorer of the Brain. FRANCIS SCHILLER. University of California Press, Berkeley, 1980. x, 350 pp., illus. \$25.

Paul Broca (1824-1880), one of France's most outstanding medical scientists and practitioners, was a pioneer of cerebral localization, a founder of an-

thropology, and the author of over 500 publications on these and related topics. His name is associated with one of the brain's speech centers, "Broca's area," and with the motor disturbance of speech, "Broca's aphasia," due to a lesion of that area and has other eponymous associations including a hospital and a street in Paris. He was a typical 19th-century polymath and much involved with the social upheavals of his time.

It is, therefore, surprising that Schiller's study is the first biography of him. Judging by its excellence there will be no need for another for many years. Schiller writes with scholarly charm, and being a neurologist he is especially well equipped to deal with the neurological aspects of his subject's work. He has based the book on wide reading, on Broca's correspondence, and on interviews with his descendants. It contains

A page from Broca's manuscript on the olfactory center, showing his drawing of the brain of a dolphin, inferior surface of left hemisphere. "As the prototype [for his comparative studies of the olfactory center] Broca used the brain of the otter, for it occupies an intermediate position between the osmatic and anosmatic type of great limbic lobe. The aquatic mammals, e.g. the dolphin family, occupy the extreme end of the series. In them the olfactory apparatus is non-existent: 'everything has disappeared, not only the olfactory lobe, but even the olfactory nerve fibers. . . . Their hippocampal lobe [H] is reduced to a minimum . . . and even smaller than in the primates . . . an olfactory desert.' " [*Mémoires d'Anthropologie de Paul Broca*, vol. 5, p. 334 (1888); reproduced in *Paul Broca*]

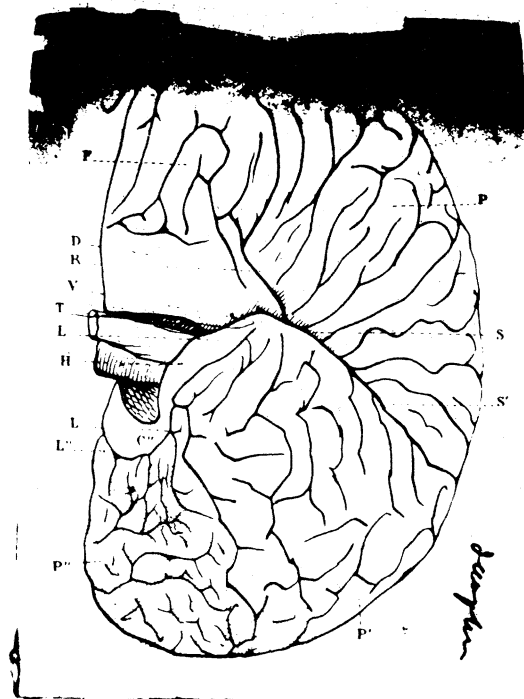


fig 9 - L'encéphale; face inférieure de l'hémisphère gauche.

RR, suture de Rolando; SS', suture de Sylvius; PPT' lobe pariétal; F, face inférieure du lobe frontal; D, lobe dorsal du lobe frontal (desert olfactif); V, vallée de Sylvius; H, lobe de l'hippocampe atrophié; C, lobe du corps calleux; L', arc inférieur de la scissure limbique; L'', arc supérieur ou raccombré; T, le pôle temporal antérieur (ou lobe) temporal; B, boudoir optique (avec l'oreille B, mais par le nez, et l'œil placé au-dessus de T et B.)

fig 27. - p. 454 T.I., 1878

material not previously printed, some of it in the form of quotations. The text is liberally referenced, but by a somewhat laborious mechanism by which one is handed from the text to a section of references (no "notes") and thence to a general bibliography. The book includes a bibliography of Broca's writings that displays his wide interests.

Schiller traces Broca's scientific work carefully and also presents its cultural and social milieu. Thus, in addition to an engaging biography of a remarkably versatile man we are given an account of 19th-century France with all its political and social complexities. Broca's personality is also examined and he is shown to have been a man of charm, drive, originality, humor, aggressiveness when needed, humanity, and hatred of bias. He was much concerned with the practice of science in general, and, although not advising scientists to avoid philosophy, religion, politics, and social or humanitarian problems, he insisted that those concerns should never be allowed to enter their professional activities. He typified his ideals by his own involvement in the various disciplines he helped to advance.

As Schiller suggests, Broca, who toward the end of his life ranked with Louis Pasteur and Claude Bernard in the hierarchy of French biological science, has not been given his due in the history of medicine. The diversity of his activities has so far eluded the casual historian, as Schiller puts it. Now in his centennial year he has found a biographer who can encompass his life and work with skill, scholarship, and understanding.

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