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velocities at which they were moving away, he found that the velocities at which the galaxies receded were proportional to their distances. The Hubble law implies, the authors note, "that the universe is expanding: velocities seem to increase as one looks progressively farther outward from any point within the universe." The tall and handsome astronomer with a movie star's "compelling personality" had shown that the cosmos could no longer be regarded as static, and he pointed the way toward the "big bang theory" of the origins of the universe.

### *Aristotle's Paternity Claim*

"Seeing Biology Through Aristotle's Eyes" by Robin Dunbar, in *New Scientist* (Feb. 20, 1993), Stamford Street, London SE1 9LS.

The intellect and greatness of Aristotle (384–322 B.C.) spanned many fields; but he seldom is regarded as the father of modern science. That honor usually goes to Francis Bacon (1561–1626), who denounced Aristotle's metaphysics and influence. Yet the credit for establishing genuine empirical science should go to Aristotle, contends Dunbar, a biological anthropologist at University College, London. In the philosopher's long-neglected work in biology, Dunbar says, he departed from the abstract cogitation favored by the ancient Greeks and pioneered the careful observation and deduction of causal explanations that became the foundation of empirical science.

"Aristotle's biology has stood the test of time in a way that his physics (which very conspicuously lacked an empirical dimension) has not," Dunbar observes. Aristotle's major biological works—*The Parts of Animals*, *The Natural History of Animals*, and *The Reproduction of Animals*—"read almost like modern textbooks." Some of his findings were not improved upon until recent decades.

"Time after time, Aristotle gets it right," Dunbar says. "He recognized the distinction between homologous and analogous parts—that some features of unrelated animal species are similar because they derive from the same common ancestor (like feathers and scales), whereas others represent convergent evolution from unrelated ancestors (like the wings

of birds and insects)." From his detailed studies of anatomy, Aristotle grasped that dolphins are mammals, not fishes, something that even the great Swiss naturalist Charles Bonnet, at the end of the 18th century, did not understand. Aristotle discovered that some sharks gave birth to live young—which was not apparent to later scientists until the 1650s. He was the first to realize that the seed of a plant is equivalent to the embryo in animals, and that the mammalian fetus is fed directly through the umbilicus.

Aristotle had no theory of evolution; he thought that species were more or less fixed for all time. But he did understand adaptation. "Nature," he observed, "makes the organs to suit the work they have to do, not the work to suit the organ."

As a purely descriptive anatomist, Dunbar writes, Aristotle was first-rate. He correctly described the Eustachian tube that connects the middle ear with the throat; the next scientist to do so was the Italian Bartolomeo Eustachio in 1550, and he got the credit.

Even Aristotle made mistakes, of course. He contended, for example, that fleas and bugs are created out of mud. But in case after case, Aristotle did caution his readers: "The facts have not yet been sufficiently ascertained. If at any time in the future they are ascertained, then credence must be given to the direct evidence of the senses rather than to theories." Spoken like a true father of science.

### *Ferris At The Wheel*

"The Ferris Wheel on The Occasion of Its Centennial" by Henry Petroski, in *American Scientist* (May–June 1993), Sigma Xi, P.O. Box 13975, Research Triangle Park, N.C. 27709.

A century ago, when the World's Columbian Exposition in Chicago celebrated the quadricentennial of Columbus's landing in America, the exposition's organizers faced a challenge: how to outdo the Eiffel Tower, the centerpiece of the French Exposition Universelle of 1889. "American pride was at stake," as one observer commented.

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The episode, writes Petroski, a professor of engineering at Duke University, is a vivid reminder that engineering achievements are often driven by the needs of the day, not simply by the implacable advance of technical knowledge. The man who took up the challenge to American pride was George Washington Gale Ferris, a Pittsburgh engineer. Inspiration, he later said, struck him at a dinner in a Chicago chophouse: "I would build a wheel, a monster."

Ferris's wheel was not entirely original. An English traveler wrote of seeing a "pleasure wheel" in 17th-century Bulgaria, and there were pleasure wheels some 50 feet in diameter in 19th-century America. The 250-foot diameter of the Ferris wheel, however, *was* new. At the fairgrounds, eight 20-foot-square holes, each 35 feet deep, had to be dug and filled with concrete to support the legs of the wheel. The wheel's components were shipped from Detroit in 150 railroad cars. The 45-foot axle—the longest steel shaft ever forged—weighed 45 tons. The wheel had 36 cars, each the size of a trolley car and each capable of seating 40 passengers. The Ferris wheel was a great success. Excited fairgoers were undaunted even by the extravagant price: 50 cents for a 20-minute, two-revolution ride. (A carousel ride cost only a nickel.)

The original Ferris wheel's moment of glory was brief. After the exposition, it was moved to a small Chicago amusement park, but the park did not attract enough visitors to keep the wheel turning. The Ferris wheel was re-erected for the 1904 Louisiana Purchase Exposition in St. Louis, then abandoned.



Published in 1893 while the Ferris Wheel was still under construction for the world's fair, this sketch provided an advance look at the technological marvel.

The "rusting eyesore" was dynamited in 1906. Ferris himself had died of typhoid fever 10 years earlier. But today Ferris wheels "remain a staple of midways," and Ferris's engineering achievement has given birth to a whole new breed of carnival wonders, including the Wonder Wheel, the Zipper, and the Sky Whirl.

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## ARTS & LETTERS

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### *Boswell's Botched Life*

"The World's Worst Biography" by Donald Greene, in *The American Scholar* (Summer 1993), 1811 Q Street N.W., Washington, D.C. 20009.

Two centuries have passed since the publication of James Boswell's *Life of Samuel Johnson* (1791), and scholars of 18th-century literature, as well

as many other educated people, continue to look upon the work with reverence. Many consider it the finest biography ever written. Greene, a Johnson scholar, emphatically does not.

Boswell (1740–95), he complains, devoted only one-sixth of his *Life* to Johnson's first 54 years, the period of his greatest intellectual activity. Boswell instead preoccupied himself with the final 22 years of the renowned poet, critic,