
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.