

his humane culture. Santillana is both historian of science and man of letters. For the most part these are essays in interpretation—imaginative, suggestive (if not always convincing), and sometimes polemical, written with wit and irony and that sort of throw-away audacity so typical of his conversation and, I suppose, of his teaching.

The most sober-sided of these papers are the two earliest in date: his discussion of "Scientific Rationalism," originally published in the *International Encyclopedia of Unified Science* in 1941, and his "Eudoxus and Plato" (1949). Among the more recent articles are the sympathetic portrait of Leonardo da Vinci and an admirable piece on Paolo Toscanelli seen in the milieu of Florentine artists and architects. This important theme—the relation of the Italian Renaissance to the rise of early modern science—Santillana had earlier treated in a study reprinted here on the role of art in the scientific renaissance.

In one of his essays Santillana borrows a phrase from Nietzsche: "every mold of our thought was created in Greece during the earliest centuries." True or not (this is the sort of challenge he likes to throw out), it is true of Santillana's way of looking at the history of thought. For him, Greece is the touchstone; and the Italian Renaissance (its reincarnation) is his second love. Galileo is the central symbolic figure linking the Ancients with the Moderns. Of course this way of viewing the rise of modern science is no longer fashionable—indeed, it was the interpretation of men of the 18th-century Enlightenment. But there are signs that historians of science are having a change of heart, and Santillana may help free us from too exclusive a dependence upon the schools of Duhem and of Thorndike.

These essays, in Santillana's typical manner, defy the chronological and subject boundaries of the great men and great ideas he treats. Niels Bohr appears in a discussion of Bruno and Leibniz; Valéry and Heraclitus in the paper on Einstein; and, of course, the Oppenheimer affair is compared (point by point) with the Inquisitional trial *de vehementi* of Galileo. For Santillana unity of thought is a unity in time as well as between disciplines.

The Renaissance had its powerful rhetorical current, where verbal *persuasio* and the arts of language meant more than syllogistic logic or the concern with prosaic fact. And this, one

feels, is true of Santillana. He has an amused disdain for pedantry and the more fusty kinds of scholarship, indeed sometimes for facts. This is true not only in the funny takeoff on Diogenes Laertius (a sketch of his one-time colleague Norbertos Vindobonensis) but even in his other pieces, which, I suspect, should be viewed sometimes as satires on the more "square" forms of scholarly writing. Santillana's purpose more often than not is to suggest a mood, an attitude toward his subject. This he does by an impressionistic approach, a beguiling style, marked by deliberate bits of mystification, verbal sorties, and swift evasive action. These, I repeat, are the essays of an amusing, thoughtful man of letters. They should be read *cum grano salis* for the sheer pleasure they give, but not by the uninitiated.

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Plant Pigments

Comparative Biochemistry of the Flavonoids. J. B. HARBORNE. Academic Press, New York, 1967. vii + 383 pp., illus. \$16.

When an acknowledged expert writes a book on his subject, it is almost certain to be a good book. This is particularly true when no comparable treatment of the subject has appeared for 40 years. Considering the great interest in the flower pigments from the viewpoints of genetics, horticulture, and chemical taxonomy, it is indeed remarkable that no one has attempted to treat the biochemistry of this group of substances since the late Mrs. M. W. Onslow, the second edition of whose book on the anthocyanins appeared in 1925. In the interim there have of course been a number of reviews, and the purely chemical side was treated by Dean and by Geissman in the early 1960's, but the biochemical and biological viewpoint has waited an unconscionably long time for incorporation into a full treatment. Unlike Mrs. Onslow, furthermore, Harborne covers all the members of the group—flavones and flavonols, isoflavones, the curious C-glycosyl derivatives, and even the unrelated "nitrogenous anthocyanins" or betacyanins, with indolic and other bases.

Thoroughness is the keynote. Not only the formulas but the occurrence in

plants is given *in extenso*. The fantastic Table 1.6 has the modest heading "*R_f* Values and Sources of All Known Anthocyanins" and gives *R_f*'s in four solvents and the genus and species of the principal source for each substance; it is five pages long. A page of spatial formulas gives the structures of all the known carbohydrates found in flavonoids. Absorption peaks are listed wherever they are known. Literature references from 1835 to 1966 cover 21 pages.

Chemical taxonomy provides a second major part of the book's interest, and many pages of tables list the red, blue, purple, and yellow pigments of dicotyledons, monocotyledons, and gymnosperms wherever they have been identified. It is notable how many plants have leucoanthocyanidins in their leaves, and since these are converted readily to anthocyanidins on being warmed with acid the chemical taxonomist can be easily confused by them. Horticultural varieties, of course, provide other sources of complication, as the Robinsons long ago found.

The least satisfactory part of the book is that dealing with physiology. Although light is a major factor in the formation and interconversion of flavonoids, the role of light in controlling anthocyanin formation is given brief and rather superficial treatment. The numerous action spectra—different in different plants—are neither presented nor discussed. Although the author notes that the application of probable precursors (other than sucrose) almost never increases anthocyanin formation, he does not make the obvious deduction, namely that substrate is not the limiting factor. The corollary, that one or more enzymes are the limiting factors, is the key to understanding all the experiments with purine antagonists, antibiotics, and ribonuclease, for these all point to the generalization that control is exercised primarily at the level of *enzyme formation*. A grasp of this point could have given the physiological discussion a unity which it does not possess.

The book has no fewer than four indexes—of subjects, authors, plant names, and plant families—a feature which makes it excellent for reference and which one could wish to see more often, for good indexing is some indication of the care and thought which have gone into a book's preparation.

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