peated crimes against good English. Run your eye down a page or two of scientific writing and observe the recurrence of "thus." Strike it out everywhere, or almost everywhere, and notice the improvement. It is as if the writer is afraid that the connection of his ideas is not plain, and so "thuses" his way laboriously from sentence to sentence. Even commoner is "case." If you examine our current works on biology, you will find that they deal not with plants or animals but with their "cases." You will read that "in the case of Rhizopus the mycelium is aseptate," which means presumably that "the mycelium of Rhizopus is aseptate." A case is really a chance or event (aside from its specialized legal and medical uses), and is rarely needed in the sentences where it occurs. It may be entirely eliminated, or replaced by "organism," "species," "experiment" or whatever was really meant. Such a lack of precision and organization of thought is pardonable in rapid speech, but regrettable in writing.

Aside from the matter of taste, there are certain rules of grammar and syntax which, after all, deserve some respect. That clumsy and ubiquitous phrase quoted by Urbach, "due to the fact that," is not only verbose but, as commonly used, ungrammatical; "due" is not a conjunction. Why these five words should replace, incorrectly, the single perfectly respectable word "because" is a mystery, except perhaps to the journalists who invented the trick.

It is somewhat invidious to quote the mistakes of others, but a sentence like the following (which is not exceptional) illustrates the reality and the seriousness of the need for some attention to English: (The individual) "may disappear wholly from the community, as in *the case of the chestnut, due to blight,* though *this* is relatively rare." (Italics are mine.) The "case of a chestnut" should be the spiny fruit, though it is difficult to conceive how it can be "due to blight." Whether blight, chestnuts or the disappearance of chestnuts is rare is left to the imagination—or taste—of the reader.

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SCIENTIFIC BOOKS

THE PAPERS OF SIR WILLIAM HARDY

Collected Scientific Papers of Sir William Bate Hardy. Published under the auspices of the Colloid Committee of the Faraday Society. Cambridge University Press, 1936. 922 pp. $18.00.

THE "Collected Scientific Papers of Sir William Bate Hardy" are especially important for an era in which subjects for scientific research tend more and more to be determined by administrators or their committees and less and less by the unhampered imagination of the scientist. Sir William Hardy's first paper in 1891 was "On some Points in the Histology and Development of *Myriothela phrygia.*" In his last papers in 1933–34 he was still concerned with the problems of biology. Meanwhile, interested in systems characteristic of living matter, he concerned himself first with the chemistry of the proteins, then with the physical properties of films and of the boundary state. Although constantly employing the methods of physics and chemistry he was never an "applied scientist." Rather his inquisitive mind found new fields for exact investigation at the interface between biology, physics and chemistry.

Biologists often require for the solution of their problems a physics and a chemistry which has not yet been completely developed. As a consequence not only are advances made as a result of applications of physics and chemistry to biology, but biologists contribute innumerable new concepts, substances and principles to physics and chemistry. Often a Helmholtz or a Hardy contributes first to physiology and then to physics.

The first ten of the collected scientific papers of Sir William Hardy are concerned with morphology. The eleventh published in 1894 was a "Note on the Oxidising Powers of different Regions of the Spectrum in Relation to the Bactericidal Action of Light and Air." The bactericidal action of light having been demonstrated to be the peculiar property of light of short wave-length, Hardy characteristically investigated the relation of this phenomenon to the presence of some oxidizing substance acted upon by the blue and violet portion of the spectrum. For Hardy an observation was always a stimulus to the investigation of the underlying mechanism.

In 1899 appeared the last of the morphological papers: "On the Structure of Cell Protoplasm." Precisely because he was trained as a morphologist Hardy was in an admirable position to conclude "that the various fixing reagents are coagulants of organic colloids and that they produce precipitates which have a certain figure or structure" (p. 250). "Reagents which have any action at all confer a structure upon the colloidal matter which differs in most cases in kind, in some cases in degree, from the initial structure. Hence it is inferred that the structure seen in cells after fixation is due to an unknown extent to the action of the fixing reagents" (p. 291–292).

The conclusion that the structure of the living cell could only be deduced from the structure of dead mat-

ter if one knew not only the influence of the chemical reagents employed by the histologist but also the "coagulation (clotting) phenomena of death, as well as . . . post mortem change" (p. 292) led Hardy to turn his attention to the phenomena of coagulation and especially to those molecules of the body that are most readily coagulated: the proteins. In 1899 the transition is made from histology to chemistry. The next fourteen papers, appearing over the period ending in 1912, are concerned largely with colloidal solutions, especially with proteins.

The first paper of this series "On the Coagulation of Proteid by Electricity" in 1899 is a classic. With clarity and insight Hardy correctly interpreted the scattered information in the literature regarding the charged condition of matter and correctly deduced the amphoteric properties of the proteins. He noted that "Under the influence of a constant current the particles of proteid in a boiled solution of egg-white move with the negative stream if the reaction of the fluid is alkaline; with the positive stream if the reaction is acid" (p. 307). All subsequent work upon this important class of molecules follows from this observation. The work started in 1899 led to several remarkable papers, two of which on globulins appeared in 1905, one in the *Journal of Physiology,* the other as the Croonian Lecture of the Royal Society of that year. "Globulins are a class of proteids which occur in both animal and vegetable tissues. They are peculiar in the complexity of their relations to electrolytes. Insoluble in water, they are soluble in low concentrations of acids, alkalis, or neutral salts. In presence of acids the globulin is electro-positive, in presence of alkalis it is electronegative, in presence of neutral salts it is electrically neutral. . . . The problem I propose to consider is their diversified relation to electrolytes" (p. 430).

These papers teem with incisive original observations which, however much they have been amplified in the last 30 years, have not in any important sense required reinterpretation. In them are to be found the concept of the isoelectric point and of the stoichiometric relations of proteins to acids and bases, deduced from measurements of conductivity, viscosity and electric transport of globulin ions, and the relations of the various ionic states of globulin, as well as of neutral globulin, to neutral salts.

The development of a theoretical understanding of the behavior of globulins in well-defined systems did not however replace his interest in the state of protein in nature. "The proteids of serum are electrically inactive. Neither the whole nor any fraction moves in a field. It is not possible to detect a trace of "ionic" proteid. Dialysis or dilution disturbs the equilibrium, and "ionic" globulin appears" (p. 418). "The probability of globulin being formed owing to the decomposition of a complex proteid present in serum is urged" (p. 426). However far from his morphological interests his studies of colloidal solutions seemed to take him, he was always concerned in his study of globulins with the problem of the state of matter in nature.

The study of the movement of proteins in an electric field led many biologists to investigate "the movement of free living cells suspended in a fluid through which an electric current is passing" (p. 490). The results reported on cells were as conflicting in 1911 as were those on molecules in 1899 and Hardy felt impelled to caution that "the movement of living cells, or indeed of any suspended particles, in films of liquid a millimeter or less in depth enclosed between glass plates is not open to simple interpretation" (p. 490). By 1911 Hardy's grasp of the chemical and physical problems as they related to the charged condition of matter had reached a point where he perceived the implications of the electrical density at interfaces and of the dimensions of molecules and surface layers.

In 1911 therefore, as in 1899, Hardy again changed the nature of his investigations. His work from this time on is for the most part concerned with the physical properties of matter at interfaces. Although his interest remains that of the biologist, as is attested by his papers on "Some Problems of Living Matter," "Living Matter" and "Molecular Orientation in Living Matter," he investigated such problems as "The Influence of Chemical Constitution upon Interfacial Tension," "The Spreading of Fluids on Glass," "Boundary Lubrication," "Chemistry at Interface" and "Problems of the Boundary State."

At each level of his understanding Hardy reverted to his primary interest, and the last of the collected papers is "To Remind: a Biological Essay." In this interesting lecture he warns against certain tendencies in modern science. His words have the wisdom always associated with him by his colleagues, but more important is the example he set by his scientific life. His collected writings, beautifully published under the auspices of the Colloid Committee of the Faraday Society, are a lasting memorial to him, and for us the detailed "history of a mind" such as is not likely often to appear in our times.

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VASCULAR PLANTS

Morphology of Vascular Plants; Lower Groups. By ARTHUR J. EAMES. McGraw-Hill. 1936. $4.00.

A NEW understanding of the comparative anatomy and morphology of vascular plants is one of the more recent developments in the progress of botany. Unlike the highest animal group, the vertebrates, in which