Of special interest are the three chapters on "Vitality"; on "Phenomena accompanying Fertilization" and on "Effects of Reorganization and the Origin of Variations in the Protozoa." It is in these fields that the author has made his most notable contributions, and about concepts derived from these the entire book is centered. Further, these are the subjects that are of most general biological interest, and on which there has been most discussion and divergence of conclusion: potential immortality, senescence, rejuvenescence, the causes of decline and death. Calkins had early made his own the doctrine that the organism becomes old, "deteriorates, uses itself up, simply by prolonged exercise of its functions" (Maupas); that "the life process contains within itself the germ of death" (Hertwig) and that conjugation remedies this deterioration; produces rejuvenescence. In opposition to Maupas, Calkins held that after decline had occurred, vitality is brought by conjugation back to a high level, so that life runs in cycles, beginning at a high potential and gradually running down, until either death or conjugation occurs; the latter restores the vitality to a high level, whence again it runs down. As a measure of vitality the rate of fission is employed; this plotted shows a curve steadily descending to death or conjugation.

But the validity of this doctrine was gradually shaken. Through the work of Enriques, Woodruff, Metalnikoff and others, the necessity for this decline became doubtful; by them it was attributed, not to processes necessarily bound up with living, but to certain environmental inadequacies. When the latter were remedied, infusoria lived indefinitely, not running down, even though conjugation did not occur. The rejuvenating effect of conjugation was therefore brought strongly into question and direct evidence given, by the reviewer and others, that it is nonexistent.

But the balance was soon restored. Calkins triumphantly unearthed in Uroleptus an ideal exemplar for all the postulates of his doctrine; it regularly declines in fission rate, and conjugation restores the reproductive power. Woodruff with Spathidium confirmed this. Calkins therefore holds in the present work to his point of view.

Yet the significance of the whole was much changed by Woodruff and Erdmann's discovery of endomixis, a process in which the physiologically active macronucleus is replaced from the micronucleus (as in conjugation) but without amphimixis, or the union of two individuals or two nuclei. Endomixis restores the waning vitality as does conjugation. Calkins therefore admits that "Woodruff is quite right in stating that amphimixis is unnecessary for continued life of a ciliate" (p. 545). What is the function of amphimixis? The truth that it is "a means of inaugurating variations is undeniable" (p. 553); but Calkins still inclines to hold that it "arose in connection with some fundamental protoplasmic need," and hankers for the doctrine that this need is "a result of vital activities and changes in organization which render them (the organisms) unable to continue metabolic activities without fusion" (p. 553). And yet on an earlier page he has set forth that amphimixis is unnecessary for continued life, even in organisms in which it occurs; and that there are large groups of Protozoa in which there is no evidence of its occurrence. There are other respects also in which the presentation reflects the present unsettled state of knowledge. Calkins's "fundamental thesis" is "that continued metabolism leads to functional weakening and ultimate cessation of vitality" (p. 552). Woodruff, Enriques and many others hold that such weakening is avoidable, and due, where it occurs, to faulty metabolism resulting from environmental conditions not adapted to the organism. Calkins agrees that supplying certain environmental conditions may remedy the weakening; "individuals might thus be 'doctored' at intervals with a resulting repression of cumulative differentiations and a corresponding maintenance of youth" (p. 478). The diversity of view on this matter, so far as possible experimental detection of differences is concerned, is whittling down to an extremely fine point.

On other questions, as on these, the discussion inclines to a conservatism that is undogmatic and at times wavering; with full presentation of opposing points of view. The book will serve, not only as a compendium of the significant knowledge on Protozoa, but as an excellent guide to the present situation in many fundamental problems of biology.

H. S. JENNINGS

The Elements of Physics and Chemistry. By VERNON BOSMAN. Pp. XI, 295; Juta & Co., Ltd. Cape Town; Johannesburg.

SEVENTY to one hundred years ago it was customary to begin text-books of chemistry with a presentation of the more important laws of physics. At the present time the fields of chemistry and physics overlap at so many points that several of the most important advances in chemical science have been contributed by men who were trained primarily as physicists. This is so true that it is scarcely profitable to ask of some topics whether they belong to physics or chemistry. The book we have before us is intended to supply the necessary information and training for students to meet the requirements of the matriculation examinations in South Africa.

The portion of the book on physics confines itself

to the elementary laws of density, statics and dynamics, heat, calorimetry and the properties of liquids, gases and vapors. The chemical portion includes the fundamentals of the atomic and molecular theories and information about hydrogen, oxygen, chlorine, nitrogen, sulfur and carbon. Each part includes a considerable number of problems and the whole should furnish an excellent basis for the further study of the subjects in a college or university.

It is well worth while for American educators to consider whether a year in the high school given to the study of the two subjects would not be better than a year devoted exclusively to one or the other. Certainly every high school student should have as good a knowledge of both subjects as can be acquired from this book.

W. A. NOYES

SCIENTIFIC APPARATUS AND LABORATORY METHODS

OPTIMUM CONDITIONS FOR MUSIC IN ROOMS

MUSICIANS complain that rooms are usually ruined for music if they are adjusted by sound-absorbing materials to give "perfect" acoustics. On the other hand, rooms left reverberant so that musicians find it "easy" to play and to sing are quite objectionable for satisfactory listening.

This apparent contradiction has puzzled the writer for a number of years, so that recently a series of experiments was conducted to discover the facts, if possible. One experiment consisted in having musicians play first in a very "dead" room, and then later as the reverberation was progressively increased by removing portions of sound-absorbing material. At first it was "hard to play" in the room, but it became easier as the reverberation increased, until finally the notes "ran together" and several instruments could hardly be played in proper time in concert because of the overlapping sounds; but it was still easier to play than before. At the same time, listeners in the room found the conditions worse and worse as the reverberation increased. An experiment conducted in the reverse order, with the room very reverberant at first and then made successively deader, led to the same conclusions.

Further experiments were conducted in other rooms, the volumes varying from about twelve thousand to two hundred thousand cubic feet, and it was again found that musicians found reverberant conditions satisfactory for playing, but that listeners heard better in portions of halls that were deadened.

A crucial experiment was then devised in which a small studio was adjusted by sound-absorbing materials to give "perfect" conditions for listening in accordance with optimum data.[1] Expert musicians forming a string quartet were interested to assist in the experiment and play in the room. Their comment was immediately adverse. Some of the sound-absorbing material near them was then moved to the far end of the room and the playing resumed. The conditions for playing were "better," and listeners in the room decided the music sounded better. More material was moved in the same manner with greater improvement. Finally all the material about the musicians was transferred to the other end of the room. The room was then regarded as quite perfect for both playing and listening.

This simple experiment makes it clear why deadening a room in the usual manner ruins it for music. Musicians find it hard to play if surrounded by sound-absorbing materials, and the resultant music is not acceptable for listeners, so that the effect is unsatisfactory to all. By shifting the sound absorbents to one end of the room, a reverberant space is left for the easy generation of music—the musicians find free expression for the finer details of compositions and the listeners are doubly fortunate in having good music to listen to and in having a deadened surrounding which makes listening enjoyable. In other words, the conditions in the same room must be quite different for playing and listening. The time of reverberation was found to be the same in all parts of the room, but the intensity of sound was much greater near the musicians than in the deadened end of the room.

The results of this experiment should find application in many halls that are now unsatisfactory in acoustic effect. For instance, in a concert hall, the stage should be left quite reverberant, but the audience section should be deadened in accordance with the optimum data already mentioned.

One concert that was puzzling to the writer is now easily explained. In a large auditorium at the university, a piano concert was given by Paderewski. Preliminary calculations indicated that "perfect" conditions would obtain if six thousand seven hundred auditors were present, because of the absorption of sound by the clothing worn. Actually five thousand five hundred people attended, yet Paderewski stated the hall was "wonderful in its response," and the audience regarded the hearing conditions as "fine." What happened was that a considerable space was left vacant about the platform upon which the piano was placed, and this space together with nearby reverberant walls and ceiling gave acceptable conditions for playing. The audience was packed closely

[1] Wallace Sabine, "Collected Papers on Acoustics," page 76; F. R. Watson, "Acoustics of Buildings," page 30; S. Lifshitz, *Physical Review*, Vol. 27, page 618, 1926.