

Borderlands. A significant list of topographic maps to be consulted is placed at the end of each chapter, together with selected references for additional reading. A laboratory manual to accompany the volume is in preparation.

As would be expected from Dr. Atwood's long study of the region, one of the most important chapters of the book is that on the Rocky Mountains. Here he presents again his belief in the essential unity and late development of the "Rocky Mountain peneplain." While rightly emphasizing the opportunities for the superimposition of rivers from plains of basin filling, as an origin for many canyons in the Rockies, he does not exclude the older idea of antecedent streams for some of the gorges.

The volume is a modernized text in which the landscape is often described as seen from the air, and it is illustrated with superb pictures, especially those taken from aeroplane by Dr. Barnum Brown over the Western United States and by Bradford Washburn in Alaska. Perhaps the most effective teaching device of the book, however, is the number of strip structure-surface diagrams, executed by Dr. Raisz, illustrating cross sections of the physiography of the various provinces. With but few lines, surface and underlying structures are surprisingly well indicated.

Dr. Atwood's volume is an excellent teaching book and it should expand the number of students and of courses offered in the basic study of the physiographic regions of the North American Continent.

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PLANT PHYSIOLOGY

Plant Physiology. By BERNARD S. MEYER and DONALD B. ANDERSON. New York: D. Van Nostrand Company, Inc. 1939. \$4.50.

THIS book is undoubtedly the outgrowth of a rich experience in the teaching of plant physiology at two prominent American universities and must be classed among the best of the text-books dealing with the various phases of this subject. The thirty-seven chapters of the book are arranged in logical sequence. Prominence has been given in the first few chapters to a discussion of the important properties of solutions and colloidal systems and thus at the outset providing the student with a fundamental background for a better understanding of the biological processes involved

in the complex living system. Although no attempt is made to discriminate sharply between the purely physical and the purely chemical characteristics of the subject-matter, the first eighteen chapters deal primarily with the physical phases of plant processes, while the following fourteen chapters are devoted largely to the factors and principles involved in the chemical aspects of plant life. The last five chapters, which deal with the factors involved in growth and movement, are rather brief (perhaps too brief) but may be adequate for the purpose intended. The discussion questions, suggestions for collateral reading and selected bibliographies at the ends of the several chapters have been selected with discrimination and if properly used should develop in the student accurate reasoning, a keen perception of principles involved in physico-chemical processes and an understanding and appreciation of plant physiological material in general. The text material presented is based almost exclusively upon data selected from original sources, and in this a prominent place is given to the discussion of modern developments in plant physiology, without, however, neglecting the older concepts. The book is thoroughly up-to-date, but not particularly historical in its emphasis, a feature which, when the book is used as a class text, affords the instructor excellent opportunity to enrich the discussion of the subjects presented by amplifying the authors' presentation. The text material is presented in a manner so clear and definite that a minimum of efforts is required to understand the authors' meaning, which is never in doubt. A strong feature of this book, as a college text, is a minimum of controversial material and the honest attempt at evaluation of such conflicting evidence as is presented. When theoretical discussions are presented, they are duly stated as such to differentiate them from the purely factual scientific material.

The book is admirably adapted for use with large classes of undergraduates where adequate attention to the individual student by the instructor is only a remote possibility, nor is it too elementary to be exceedingly helpful to the appreciative graduate student in this field. It is a most welcome addition to the growing list of American text-books on this subject and fills a long-felt need for a comprehensive, thoroughly up-to-date college text-book of plant physiology.

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REPORTS

PHILANTHROPIC FOUNDATIONS¹

THE Carnegie Corporation was specifically chartered for the advancement and diffusion of knowledge

¹ Concluding part of the report of Dr. Frederick P.

and understanding, and these words pretty accurately set forth the broad purposes of any non-specialized

Keppel, president of the Carnegie Corporation, New York, for the year ending September 30, 1940.

American foundation. If this be true, the definite steps these foundations take in the realization of their purposes must of necessity center around inquiry and research for the advancement, and around education, taken in its broadest sense, for the diffusion of knowledge and understanding. Research is a cruelly overloaded word as it is used to-day, and while it may be assumed that an intelligent foundation will not be deceived by obvious misuses of the term, it must be recognized that some of the overloading is due to confused thinking by sincere and earnest people, one example being the efforts of a few years ago to transfer bodily the techniques of the natural sciences into the field of social and educational inquiry.

Certain grants for research have proved, though not always immediately, to be the best of all possible investments for a foundation to make; on the other hand, a research grant may prove to be an almost perfect device for wasting money. It is hard to assign either credit in the first instance, or blame in the second. All along the line the foundation is faced by a series of dilemmas in the selection of research enterprises to support. Here is a field in which the dollar provides no measuring line, for the necessary cost of any particular inquiry is a purely incidental feature which offers no criterion of relative usefulness to mankind. We are told, by those whose own researches have earned them the right to tell us, that nothing is more fatal than an attempt to regiment in any way the spirit of human inquiry, and yet our common sense tells us that the chances of success can not but be enhanced by environmental factors which *can* be controlled, such as adequate equipment, and understanding and stimulating personal contacts.

Fundamental research will always be a highly speculative enterprise, and the present foundation device for selection, while it can certainly be operated more carefully and more intelligently, is in general about as sound as can be hoped for. This device is to get, through consultation with experts, as fair a picture as possible of the fundamental nature of each proposed inquiry, and of the human qualities of the inquirer or inquirers, and then to leave the selection of those to be supported to the lay judgment of the board, decision to be made in terms not only of comparative promise, but also of the funds which the foundation itself may have available, and the chances of support from other sources.

And now, as to the second major channel of productive activity, education. Research can go it alone; education requires public approval and, if possible, public understanding as well. We have to-day the favorable factor of growing public interest in this our largest national industry. In such matters the radio serves as a useful barometer, and it is therefore significant that twenty-four coast-to-coast broadcasts

were provided last year for a single educational meeting, that of the American Association of School Administrators. Much, however, remains to be done to clear the public mind as to what the public itself wants from education, and what it can reasonably expect, and by the same token to clarify the teachers' ideas as to what the processes of formal education can and can not do to affect the social order.

In the writer's judgment this whole matter of understanding, alike for the student, the teacher and administrator, and the public at large, must begin by the grasping of two or three fundamental concepts. The first is the enormous range in the native abilities of different individuals. This we "know" in one sense of the word, but we fail to make practical use of our knowledge. It is not so widely "known," but is demonstrably true, that there are corresponding qualitative differences in the various groups of human beings which constitute our universities and colleges and our other types of educational and cultural agencies, and it is equally demonstrable that most people act as if these differences did not exist. A fuller and wider understanding in both instances and a willingness to act in recognition of such understanding might do more than anything else to advance the cause of American education at all levels.

We recognize in our system of professional and vocational training the relationship between what we teach our students and what they must later do to make a living, but we are not nearly so clear as to the relationship between the durable general knowledge and the attitudes which the students acquire throughout their education, and the broad realities and the urgent needs of the adult life they must enter. In this connection the writer takes the opportunity to reiterate his conviction that as a people we have signally failed to get the use we might out of one of our most costly national investments, namely, the great body of our professionally trained men and women. They serve us as individual experts, it is true, but fail to serve as they might as united and influential citizen-groups in our communities. The responsibility for this failure must be laid at the door of education, including adult education.

We are ready to give lip service to the thesis that the logical unit, the center of education, must be the individual student and not the curriculum; but how precise is our thinking on what this means concretely, and how generally do we practice what we preach? How clearly do we grasp the underlying unity of the educative process as a whole, a process beginning for each human being with birth and ending only with death? The lines dividing education horizontally into pre-school, elementary, secondary, higher and adult education, and vertically according to subjects of study, have their usefulness certainly. So have our

parallels of latitude and the meridians of longitude, but it is well to remember that these latter exist only on our maps; we never find them on the face of nature.

If it be true that a foundation of broad charter must of necessity concern itself primarily with matters of research and education, broadly conceived, and if the general considerations thus far presented, and others like them, are valid considerations, we find ourselves facing still another aspect of foundation responsibility. With rare exceptions a foundation can reach its objective only by working through another institution, and there are to-day in the United States far more universities, colleges and other operating institutions, and far more voluntary organizations for worthy purposes than the nation can possibly afford. In the years to come many of these are bound to disappear, and one of the most difficult duties that face the foundation is that of so directing its grants that its influence will be directed toward the survival of the fittest.

These various problems have forced themselves upon our attention during times which, by comparison at least, were normal. The inescapable fact that we are to-day in a tragically disordered world is in itself a further challenge to the foundation to justify its place as a social instrument enjoying exemption from taxation and other valuable privileges. In the face of falling income and increasing calls from every source, will foundations be able to find the things to do upon which their particular assets can be brought to bear most effectively? While they have their limitations, their natural advantages are many. They can move quickly. They can continue their support past the

stage of novelty and publicity appeal. They can act with the long view in sight rather than under the pressure of the moment. They can call upon competent and disinterested advice. They can recognize and encourage excellence and the promise of influence and leadership in the individual, the group or the institution. They can find situations which it is to the general interest, but alas nobody's particular business, to clarify by research and experimental demonstrations. It need scarcely be added that no foundation has ever availed itself of these natural advantages to the full. It is equally true, however, that certain of them in the light of their own experience and of a wider public understanding of their responsibilities are each year giving greater weight to these matters in their decisions.

It is hard at any time for a foundation to keep its head amidst exigent and conflicting calls. It is doubly so in times of national tension and excitement—excitement in which, be it remembered, trustees, staff and advisers alike share. It is perhaps hardest, as pointed out in an earlier report, to go on with the familiar tasks, tasks so familiar that we are prone to forget that they may also be essential. Those of us who have had long years of experience in foundation work can not help recalling the errors and missed opportunities of the past, but on the whole, and all things considered, the writer is confident that the American foundation as an institution will meet the double challenge of a critical present and an unpredictable future.

FREDERICK P. KEPPEL,
President

SPECIAL ARTICLES

THE QUANTUM OF SENSORY DISCRIMINATION

THE human organism can detect a change in a stimulus when its intensity is increased by a sufficient increment. This increment alters, presumably, a level of excitation somewhere in the nervous system, and the change in nervous activity leads to a discriminatory response. Problem: Does the change in nervous activity proceed by infinitely small increments or does it proceed stepwise by finite increments or quanta? And are these quanta reflected in the discriminatory response itself?

The classical theory of psychophysics assumes that the frequency with which a given increment in a stimulus will be noticed is governed by the theory of probability,¹ and that an extremely small increment

will occasionally produce a discriminatory response. The quantal theory, on the other hand, assumes a limiting value below which an increment will always fail to produce a noticeable difference. The contrast between these two theories is analogous to that between the classical theory and the "quantum theory" of physics.

But the existence of the sensory quantum is difficult to demonstrate. Almost without exception the experimental results conform best to the classical theory: the relative frequency with which an increment is perceived is related to the size of the increment according to a sigmoid function (the normal probability integral). The differential sensitivity of the organism is apparently "normally" distributed in time.² The quantal theory proposes that this result is due to the

¹ J. P. Guilford, "Psychometric Methods," McGraw-Hill, 1936, p. 173. Guilford presents Boring's early argument regarding the applicability of probability theory to psychophysics. Boring later suggested the possibility of finding the sort of critical points in a sensory "con-

tinuum" which would demonstrate a "quantum theory." See E. G. Boring, *Am. Jour. Psychol.*, 37: 157-188, 1926.

² H. C. Montgomery, *Jour. Acoust. Soc. Amer.*, 7: 39-43, 1935.