description of science and scientific method is certainly inadequate. Astronomy has done very well without subjecting the behavior of stars and planets to experimental controls. Geology has not used this method to any notable extent. Most of Darwin's contribution to biology did not come from such an experimental basis, either in its conception or verification. A problem need not be inaccessible to science if controlled experiments are impossible.

It may be true, as Dr. Bender says, that "social science studies conducted to date, with minor exceptions, have been observational and statistical rather than experimental" and that "understandings so achieved are only approximations, and in many cases inaccurate approximations at that, due to inherent limitations of the methods employed." But of course all the understandings achieved by the physical and natural sciences are also only approximations, and of varying accuracy. Fortunate are those scientific disciplines that can, for most of their problems, use the method of controlled experiment to test and improve the accuracy of their hypotheses. The history of these sciences, however, does not suggest that this is the only scientific method of verification, or that the social sciences must choose the method of control (which is so greatly limited in a democratic society) or be denied the status of sciences.

It would be more useful if the physical and natural scientists, instead of preaching a particular procedural definition of scientific method and commending this to their social science colleagues, would recognize that the division of science into the accepted disciplines is merely a convenience arising from the varieties of methods and interests most useful in investigating different aspects of experience and expectation. Science is not any particular method or set of techniques. It is a way of reasoning. The standards are intellectual rather than procedural. The method of observation, formalization, and testing must vary with the nature of the problem.

There is no unique kind of difficulty facing the social sciences that is not met, at least to some degree, in the natural sciences. All sciences must, in some phase and field, and to some extent, try to cope with such restrictive troubles as a high degree of indeterminacy, a highly heterogeneous universe for sampling, the impossibility of controlling variables, the difficulty of translating a factor or concept into an operationally definable identification or measurement, the need for including the inaccessible past history of a datum in an observation, the effect of observer on observed, and a host of other puzzles which challenge the scientific ingenuity and skill of the investigator. Most of these loom much larger in the social sciences, which have in general a more difficult task than the natural sciences. The need for studying and developing the nonexperimental approaches of scientific method is great, since the applicability of controlled experimentation is so limited.

The field of social science, being in effect the problem of how and why mankind behaves, embraces many sciences. The present state of relative isolation of the social sciences from the other sciences (and, indeed, from each other) should not be continued. Social science must draw, in part, on the methods and content of other scientific disciplines; philosophy, the humanities, and religion can also contribute. In turn, social science contributes to the development of scientific method and knowledge for all of science.

There is general agreement that our greatest need is an improvement in behavior and in the prediction and control of behavior and that while our accomplishments in material technology are promising, they are also an overwhelming threat if not accompanied by social advance. Translation of religion into practice by the mass of mankind could solve many of our troubles, but this can hardly be a sufficiently rapid rescue in our present emergencies. Man's most urgent problems are in the area of the social sciences. Their solution will not be speeded by trying to remold these sciences into the image of physics, chemistry, or biology. It may be aided by recognizing that the validity of scientific method is not confined to any one procedure, that methods now in use are open to critique and improvement, that methods developed in one field may presently find unsuspected utility in other fields, and that there may be new methods yet undiscovered.

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Colloidal Electrolytes as a Class Inclusive of Polyelectrolytes, Chain Electrolytes, Long Chain Salts, Dyes, and Detergents

Colloidal electrolytes form one of the largest groups of colloids. In aqueous solution they exhibit properties of both colloids and electrolytes. The author suggested in 1912 (J. W. McBain, E. C. V. Cornish, and R. C. Bowden. *Trans. chem. Soc.*, 1912, **101**, 2042) that this was due to the presence of both charged colloidal particles and ordinary ions. Typical examples were soaps and proteins. The former are association colloids whose particles or micelles are formed by association of ions; the latter are high polymers carrying dissociable groups that are exposed to the solvent.

This classification of colloidal electrolytes has long met with international acceptance, and an extensive literature on the subject has grown up, especially since the advent of synthetic detergents. As early as 1934 the Faraday Society organized an international symposium of over 400 pages on colloidal electrolytes, including such materials as cellulose, starch, proteins, gelatin, dyes, silicates, and a number of inorganic materials (*Trans. Faraday Soc.*, 1935, 31, 1–421).

Recently (*Science*, November 19, 1948, p. 545) the term "polyelectrolytes" was "coined to describe substances of high molecular weight which are simultaneously electrolytes." The new term was to include "the naturally-occurring polyelectrolytes such as proteins and polysaccharides'' and ''synthetic materials.'' It was shown that polyelectrolytes are highly associated in solution. It was further suggested that ''some of the problems of the biochemist will be reduced to special problems in a broader field—that of polyelectrolytes in general.'' However, these colloidal electrolytes, such as bile salts, have already received much attention both from physical chemists and biochemists, and their properties are just as closely related to the other colloidal electrolytes excluded in the quoted definition of ''polyelectrolytes.''

It would seem that the introduction of such a term would merely lead to confusion in this well established field. The term polyelectrolytes is not self-explanatory and might seem to refer to polyvalent electrolytes or to those that give rise to a variety of ions.

In a previous paper the term ''chain electrolytes,'' which seems equally inapt, was coined (D. Edelson and R. M. Fuoss. *J. Amer. chem. Soc.*, 1948, **70**, 2832). Another partial term is that of ''long chain salts'' (P. F. Grieger and C. A. Kraus. *J. Amer. chem. Soc.*, 1948, **70**, 3808), which is also inadequate.

It now seems impossible to draw a sharp distinction between polymerization and association. Aluminum soaps are one instance of a borderline case. During the past year some authors have classified these as association colloids because their particle size or molecular weight depends upon concentration. Several other authors prefer to regard them as ''polymers of high molecular weight formed by weak intermolecular links'' such as hydrogen bonds. Both groups are describing the same facts.

It would seem advisable to retain the thoroughly established name ''colloidal electrolytes'' for all such materials, even if there are subgroups such as organic, inorganic, organic-inorganic, some that are purely products of association, and others that are simple polymers, or associated polymers, etc. A subgroup such as polyelectrolytes might be useful if it were sufficiently sharply and narrowly defined to include only one definite class of materials. The term ''colloidal electrolytes'' clearly includes them all and emphasizes their interrelatedness and common properties.

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Erratum

May I point out a confusing error that occurs in the last line of Table 1 in our recent short paper (H. H. Plough and Madelon R. Grimm, ''Reversal to Penicillin Sensitivity in a Cysteine-requiring Mutant of *Salmonella*,'' *Science*, February 18, 1949, pp. 173–4). This should read: ''S. D. alone – – – – – – –,'' that is, seven minus signs instead of one minus and six plus signs. I had to correct in galley an error of the original manuscript under a similar heading five lines above, and I assume that somehow the last line got shifted too.

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Book Reviews

The chemistry of high polymers. C. E. H. Bawn. New York: Interscience, 1948. Pp. + 249. (Illustrated.) $4.50.

This is an excellent book and fills a real need in the field of polymer chemistry. While more advanced treatises on individual topics have appeared during the past few years, no other book has summarized the whole field of polymer chemistry so clearly and succinctly. The book is very readable and understandable but at the same time has neither sacrificed correctness nor oversimplified the problem.

The book is divided into the following seven chapters: Introduction: Nature and Types of Polymer; Condensation Polymerization; Addition Polymerization; Thermodynamics of Solutions of High Polymers; Size and Shape of Macromolecules; The Structure, Stereochemistry and Crystallinity of High Polymers; and Structure and Physical Properties of High Polymers. Each of these chapters is fairly complete and detailed, with the exception of the last, which is a rather brief outline of the physical properties of high polymers. Fairly extensive references to recent literature are included.

This book should be particularly valuable to the graduate student in chemistry who seeks a broad picture of the present status of polymer chemistry without the necessity of wading through four or five lengthy monographs on highly specific subjects. It also deserves a place on the bookshelves of research workers in the field of polymer chemistry.

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Lès richesses de la mer: technologie biologique et océanographique. (Encyclopédie Biologique, XXIX.) Noël Boudarel. Paris, France: Paul Lechevalier, 1948. Pp. 548. (Illustrated.) 1.500 fr.

The information collected in this volume should prove immensely helpful to the more curious fishermen along the French coasts and provide a strong stimulus to those with a bent toward natural history. In addition to short chapters on the origins and development of oceanography, the characteristics of ocean water and bottom, and the common terrestrial plants found along the seashore, there