be separated from those who study the gametophyte. It is simply the development of another line of attack upon morphological problems. This anatomical morphology, as it may be called, has yet to accumulate its share of results, and there is no region of morphology more in present need of investigators. From the small beginnings it has made it is evident that it must check the conclusions of the older morphology at every point. Even now no statement as to phylogeny can afford to neglect the testimony of anatomy.

This second phase of anatomy promises to be accompanied by a third, which finds its parallel and probably its suggestion in experimental morphology. In its incipient stage it is known as ecological anatomy, just as another phase of ecology preceded and then became merged in experimental morphology. Ecological anatomy can make no progress until it becomes an experimental subject, and then it is experimental anatomy, which holds the same relation to experimental morphology that evolutionary anatomy holds to evolutionary morphology. In other words, it is the same subject, with the same methods and purpose, and differing only in the structures investigated. And thus anatomy reaches the physiological basis, and as a part of morphology fills out the structures to be investigated from this standpoint.

There remains a region of ecology so vast and vague that it must be considered by itself for a time. It deals with such complex relationships as exist between soil, topography, climate, etc., on the one hand, and masses of vegetation, on the other. Just because it is vast and vague ought it to be attacked. The little incursions that have been made indicate the possibilities. It evidently includes some of the great ultimate problems. As yet it can not define itself, for it seems to have no boundaries. Its materials were evident but entirely meaningless in the earlier history of botany, for it needed all of our progress before it could begin to ask intelligent questions. By virtue of its late birth it promises to develop more rapidly than any other phase of botany. And yet, beyond the inevitable preliminary classification of material, its real progress is measured by its experimental work conducted upon a definite physiological basis. Tentative generalizations are numerous and necessary, but they are merely suggestions for experiment. When one understands the close analysis necessary in the simplest physiological experiment, the problems suggested by this phase of plant ecology are appalling; but I see in the whole subject nothing but the largest application of physiology to the plant kingdom.

And now that the various phases of botany all seem to rest upon physiology, it must be apparent that the most fundamental problems are physiological. It is only recently that the development of plant physiology has justified this relationship. Its own history has been one of progress from the superficial towards the fundamental, from the behavior of a plant organ to the behavior of protoplasm. And here it becomes identified with physics and chemistry; and in a very real sense botany has become the application of physics and chemistry to plants.

John M. Coulter.
The University of Chicago.

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*THE CONCEPTS AND METHODS OF SOCIOLOGY.**

To set forth in a brief paper the fundamental conceptions of any modern science is a difficult task. The difficulty increases as we pass from the relatively simple sciences that have to do with inorganic matter,

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to the highly complex sciences of life and of mind. And when we come to the phenomena presented by aggregations of living beings—phenomena of the interaction of mind with mind, phenomena of the concerted activity of many individuals working out together a common destiny—we have a subject for scientific study too many-sided, too intricate, for description in a few comprehensive phrases, and the scientific study itself arrives at fundamental conceptions only after a long and extensive process of elimination. Fundamental conceptions in such a field are necessarily general truths, expressing the relations that endless facts of detail bear to one another, or to underlying groupings, processes or causes. A brief account, therefore, of the fundamental conceptions of sociology, and of the methods available for the scientific study of society, must remorselessly exclude those concrete particulars that lend to our knowledge of collective life its preeminently real—its human—interest. It must be restricted to conceptions that are elemental, general and in a degree abstract.

Conforming to this necessity, I shall group the fundamental conceptions of sociology in three divisions, namely: (1) Concepts of the subject-matter of sociological study, that is to say, of society; (2) concepts pertaining to the analysis and classification of social facts, and incidentally to the corresponding subdivisions of sociological science; (3) concepts of the chief processes entering into social evolution, and of the inferred causes.

The word 'society' has three legitimate significations. The first is that of the Latin word *societas*, meaning 'companionship,' 'good-fellowship,' 'pleasurable consorting together,' or meaning the individuals collectively regarded that consort. Examples of society in this original sense are afforded by the commingling of familiar spirits at the tavern or the club, the casual association of chance acquaintances at the summer resort, the numberless more formal 'functions' of 'the season.' In the second signification of the word, 'society' is a group of individuals cooperating for the achievement of any object of common interest or utility, as, for example, a merchant guild, an industrial corporation, a church, a congress of arts and science. Finally, in the third signification of the word, 'society' is a group of individuals dwelling together and sharing many interests of life in common. A nest of ants, a savage horde, a confederation of barbarian tribes, a hamlet or village, a city-state, a national state, a federal empire—all these are societies within the third and comprehensive definition of the term. A scientific conception of society must lie within the boundaries fixed by these three familiar meanings, but it must seize upon and make explicit the essential fact, whatever it may be, that is a common element in all social relations.

At the present time we find in sociological literature two competing conceptions of the essential nature of society. They are known respectively as the organic and the psychological conception.

The organic conception assumes that the group of individuals dwelling and working together is the true, or typical, society, and that it is as much a unity, although made up of individuals, as is the animal or the vegetal body, composed of cells and differentiated into mutually dependent tissues and organs. Sketched in bold outlines by Herbert Spencer in his essay on 'The Social Organism' in 1860, the organic conception has been elaborated by Schäffle and Lilienfeld, and is to-day accepted as the working hypothesis of an able group of French sociologists, whose work appears in the proceedings of L'Institut international de Sociologie.

The psychological conception assumes that, whether or not the organic conception be true and of scientific importance, it fails to get to the bottom of things. It assumes that, even if society is an organism, there is necessarily some interaction of individual with individual, or some form of activity common to all individuals that serves to bind them together in helpful and pleasurable relations, and that this activity, instead of being merely physical, like the cohesion of material cells, is a mental phenomenon. It assumes that all social bonds may be resolved into some common activity or some interactivity of individual minds. It is, in short, a view of society as a mode of mental activity.

This is the psychological conception in general terms. It takes, however, four specific forms in attempting to answer the question: What definite mode of mental action is the most elementary form of the social relation?

According to the most pretentious of these answers, one that dates back to Epicurus, and lies at the basis of all the covenant or social contract theories of political philosophy, the psychological origin of society is found in a perception of the utility of association. It assumes that men consciously and purposely create social relations to escape the ills of a 'state of nature' and to reap the rewards of cooperation. This rationalistic theory offers a true explanation of highly artificial forms of social organization in a civil, especially an industrial, state, but it throws no light upon the nature of elemental, spontaneous cooperation. For this we must turn to the other three conceptions —all of them, I venture to think, modernized forms of certain very ancient notions.

According to one of these, the most elementary social fact is seen in the constraining power, the impression, the contagious influence that an aggregation, a mass, of living beings, exerts upon each individual mind. Society is thus viewed as a phenomenon closely allied to suggestion and hypnosis. This view of society is most fully set forth in the writings of Durkheim and Le Bon.

A third conception, identified with the life-work of our lamented colleague, Gabriel Tarde, assumes that impression, contagion, influence, as forms of the interaction of mind with mind, may themselves be accounted for. It explains them as modes of example and imitation. All society is thus resolved into products of imitation.

In strict psychological analysis these 'impression' and 'imitation' theories must be classed, I think, as scientifically developed forms of the 'sympathy' theories of society, that may be traced back through the literature of political philosophy to very early days. They offer proximate explanations of the great social facts of resemblance, of mutuality, of solidarity; but do they, beyond a doubt, trace concerted activity back to its absolute origin? Above all, do they account not only for similarity, but also for variation, for the differentiation of communities into leaders and followers, for competition as well as for combination, for liberty as well as for solidarity?

The fourth conception, put forth some years ago by the present writer, should be classed as a developed form of the instinct theory, dating back to Aristotle's aphorism that man is a political animal. It assumes that the most elementary form of social relationship is discovered in the very beginning of mental phenomena. In its simplest form mental activity is a response of sensitive matter to a stimulus. Any given stimulus may happen to be felt by more than one organism, at the same or at different times. Two or more organisms may respond to the same given stimulus simultaneously or at different times. They

may respond to the same given stimulus in like or in unlike ways; in the same or in different degrees; with like or with unlike promptitude; with equal or with unequal persistence. I have attempted to show that in like response to the same given stimulus we have the beginning, the absolute origin, of all concerted activity—the inception of every conceivable form of co-operation; while in unlike response, and in unequal response, we have the beginning of all those processes of individuation, of differentiation, of competition, which, in their endlessly varied relations to combination, to cooperation, bring about the infinite complexity of organized social life.

It is unnecessary to argue that this conception of society not only takes account of individuality as well as of mutuality, but that also it carries our interpretation of solidarity farther back than the theories of impression and of imitation, since both impression and imitation must be accounted for—in ultimate psychological analysis—as phenomena of reciprocal, or inter-stimulation and response. Indeed, the very language that Tarde uses throughout his exposition tacitly assumes as much. Example is stimulus, the imitative act is response to stimulus. The impression that the crowd makes upon an individual is stimulus, and the submission, obedience or conformity of the individual is response to stimulus. Moreover, the formation of the crowd itself has to be accounted for, and it will be found that, in many cases, the formation of a crowd is nothing more nor less than the simultaneous like-response of many individuals to some inciting event, circumstance or suggestion. In short, impression, imitation and conformity are specific modes, but not by any means the primary or simplest modes, of stimulation and response; and some of the most important phenomena of concerted action can be explained only as springing directly from primary like-responses, before either imitation or impression has entered into the process.

This conception meets one further scientific test. It offers a simple and consistent view of the relation between social life and the material universe. It assumes that the original causes of society lie in the material environment, which may be regarded as an infinitely differentiated group of stimuli of like-response, and, therefore, of collective action; while the products of past social life, constituting the historical tradition, become in their turn secondary stimuli, or secondary causes, in the social process.

A mere momentary like-response by any number of individuals is the beginning of social phenomena, but it does not constitute a society. Before society can exist there must be continuous exposure to like influences, and repeated reaction upon them. When this happens, the individuals thus persistently acting in like ways become themselves mentally and practically alike. But likeness is not identity. The degrees of resemblance or of difference in the manner of response to common stimuli manifest themselves as distinguishable types of mind and of character in the aggregate of individuals; while the differing degrees of promptitude and persistency in response have as their consequence a differentiation of the aggregate into leaders and followers, those that assume initiative and responsibility, and those that habitually look for guidance. These differences and resemblances have subjective consequences. Differing individuals become aware of their differences, resembling individuals become aware of their resemblances, and the consciousness of kind so engendered becomes thenceforth a potent factor in further social evolution.

Summarizing our analysis to this point, we may say that we conceive of society as

any plural number of sentient creatures more or less continuously subjected to common stimuli, to differing stimuli, and to inter-stimulation, and responding thereto in like behavior, concerted activity or co-operation, as well as in unlike, or competitive, activity; and becoming, therefore, with developing intelligence, coherent through a dominating consciousness of kind, while always sufficiently conscious of difference to insure a measure of individual liberty.

Which of these various conceptions of the ultimate nature of the social relation shall in the long run prevail must depend upon a certain fitness to account for all the phenomena of social life in the simplest terms. That fitness can be determined only through the further evolution of social theory.

But whatever the finally accepted view may be, there are certain classifications of social facts that may be accepted as among the elementary notions of any sociological system.

And first there are types or kinds of societies. The broadest groupings correspond to the familiar demarkations made by natural history. There are animal societies and human societies; and the human societies are further divided into the ethnic—or communities of kindred, and the civil—or communities composed of individuals that dwell and work together without regard to their blood-relationships.

More significant for the sociologist, however, is a classification based on psychological characteristics. The fundamental division now is into instinctive and rational societies. The bands, swarms, flocks and herds in which animals live and cooperate, are held together by instinct and not by rational comprehension of the utility of association. Their like-response to stimulus, their imitative acts, the frequent appearance among them of impression and submission, are all purely instinctive phenomena. Not so are the social relations of human beings. There is no human community in which instinctive like-response to stimulation is not complicated by some degree of rational comprehension of the utility of association.

The combinations, however, of instinct and reason are of many gradations; and the particular combination found in any given community determines its modes of like-response to stimulus and its consciousness of kind—establishes for it a dominant mode of the relation of mind to mind, or, as Tarde would have phrased it, of inter-mental activity. This dominant mode of inter-mental activity—inclusive of like-response and the consciousness of kind—is the chief social bond of the given community, and it affords the best distinguishing mark for a classification of any society on psychological grounds. So discriminated, the kinds of rational or human societies are eight, as follows:

1. There is a homogeneous community of blood-relatives, composed of individuals that from infancy have been exposed to a common environment and to like circumstances, and who, therefore, by heredity and experience are alike. Always conscious of themselves as kindred, their chief social bond is sympathy. The kind or type of society, therefore, that is represented by a group of kindred may be called the sympathetic.

2. There is a community made up of like spirits, gathered perhaps from widely distant points, and perhaps originally strangers, but drawn together by their common response to a belief or dogma, or to an opportunity for pleasure or improvement. Such is the religious colony, like the 'Mayflower' band, or the Latter-Day Saints; such is the partisan political colony, like the Missouri and the New Eng-

land settlements in Kansas; and such is the communistic brotherhood, like Icaria. Similarity of nature and agreement in ideas constitute the social bond, and the kind of society so created is therefore appropriately called the congenial.

3. There is a community of miscellaneous and sometimes lawless elements, drawn together by economic opportunity—the frontier settlement, the cattle range, the mining camp. The newcomer enters this community an uninvited but unhindered probationer, and remains in it on sufferance. A general approbation of qualities and conduct is practically the only social bond. This type of society, therefore, I venture to call the approbational.

The three types of society thus far named are simple, spontaneously formed groups. The first two are homogeneous, and are found usually in relatively isolated environments. The third is heterogeneous, and has a transitory existence where exceptional economic opportunities are discovered on the confines of established civilizations.

Societies of the remaining five types are in a measure artificial, in part created by reflection—by conscious planning. They are usually compound, products of conquest or of federation, and, with few if any exceptions, they are of heterogeneous composition. They are found in the relatively bountiful and differentiated environments.

4. A community of the fourth type consists of elements widely unequal in ability; the strong and the weak, the brave and the timorous, exploiters and the exploited—like enough conquerors and the conquered. The social bonds of this community are despotic power and a fear-inspired obedience. The social type is the despotic.

5. In any community of the fifth type arbitrary power has been established long enough to have identified itself with tradition and religion. Accepted as divinely right, it has become authority. Reverence for authority is the social bond, and the social type is, therefore, the authoritative.

6. Society of the sixth type arises in populations that, like the Italian cities at their worst estate, have suffered disintegration of a preexisting social order. Unscrupulous adventurers come forward and create relations of personal allegiance by means of bribery, patronage, and preferment. Intrigue and conspiracy are the social bonds. The social type is the conspirital.

7. Society of the seventh type is deliberately created by agreement. The utility of association has been perceived, and a compact of cooperation is entered into for the promotion of the general welfare. Such was the Achæan League. Such was the League of the Iroquois. Such was the confederation of American commonwealths in 1778. The social bond is a covenant or contract. The social type is the contractual.

8. Society of the eighth type exists where a population collectively responds to certain great ideals, that, by united efforts, it strives to realize. Comprehension of mind by mind, confidence, fidelity and an altruistic spirit of social service, are the social bonds. The social type is the idealistic.

Of these varieties of society the higher, compound communities, or commonwealths, may, and usually do, include examples of the lower types, among their component groups.

All of these eight types, and the instinctive type exhibited by animal bands, have been observed from the earliest times and have suggested to social philosophers as many different theories of the nature of society. Thus in the totemistic lore of savagery we find endless suggestions of an instinct theory. In the mythologies of tribally organized barbarians we find sym-

pathy, or natural brotherhood, theories, which later on are borrowed, adapted and generalized by the great humanitarian religions, like Buddhism and Christianity. Suggested by societies of congenial spirits we have the consciousness-of-kind theories, voiced in the proverb that 'birds of a feather flock together,' in the saying of Empedocles that 'like desires like,' in the word of Ecclesiasticus that 'all flesh consorteth according to kind, and a man will cleave to his like.' From approbational societies have come our natural-justice theories. From despotic societies have come our political-sovereignty theories that 'might makes right,' in the sense of creating law and order. From authoritative societies have come theories of the divine right of kings; from conspirital societies have come Machiavelian theories of the inevitableness of intrigue and conspiracy; and from societies long used to deliberative assemblies, to charters of liberty and bills of rights, have come the social-covenant or contract theories of Hobbes, Locke and Rousseau. Finally, from societies that have attained the heights of civilization have come the Utopian theories, from Plato until now.

Whatever the kind or type of the society, there are found in it four great classes or groupings of facts.

Every society presupposes a certain number of concrete living individuals. The basis of every society, therefore, is a population. Every social population offers for observation phenomena of aggregation, or distribution of density; phenomena of composition, by age, sex and race; and phenomena of amalgamation or unity.

The social life, however, as we have seen, is a phenomenon of mind, and the varied modes that the common activity and interplay of minds assume, present the second great class of social facts. These facts of the social mind, as we may call them, include the phenomena of stimulation and response in their generic forms; phenomena of resemblances and differences, that is to say, of types; phenomena of the consciousness of kind; and phenomena of concerted volition.

The common mental activity, taking habitual forms, creates permanent social relationships, that is to say, a more or less complex social organization. In this we meet the third great class of social facts. Two general forms may be observed. In one form, individuals dwell together in groups that, by coalescence and federation, compose the great compound societies. These groups collectively may be called the social composition. In the other form, individuals, with more or less disregard of residence, combine in associations to achieve specific ends. Such associations collectively represent the social division of labor, and, therefore, may be called the social constitution. In its entirety and in its subdivisions the social organization is of one or another type, according as it is on the whole coercive, or on the whole liberal, in character.

The fourth class of social facts pertains to the great end, to the attainment of which the social organization is a means. That end is the social welfare. The social welfare is seen in its most general form in certain public utilities, including security, justice and liberty, material prosperity and popular culture. It is seen finally in the type of personality that the social life creates, and which must be studied as vitality, mentality, morality and sociality.

Not every society individually considered survives long enough to pass through all the possible stages of social evolution, but society in the aggregate, and in historic continuity, displays to us four distinguishable stages of evolutionary advance. There is, first, the stage of zoogenic association,

in which the mutual aid and protection practised by animal bands plays an enormously important part in the differentiation of species and in the survival of those best endowed with intelligence and sympathy. There is, next, the stage of anthropogenic association, in which, through unnumbered ages, the creature that was destined to become man was acquiring the distinctly human attributes of language and reason. There is, later on, the stage of ethnogenic association, wherein is evolved that complex tribal organization characteristic of savage and barbarian life. Finally, there is the stage of civic or demogenic association, in which great peoples outgrow tribal organization, and create a political organization based on common interests, irrespective of blood-relationships.

These categories of social fact have established certain natural subdivisions in social science. Corresponding to the historical order we have, first, studies in animal sociology; second, studies of primitive human culture; third, the great sciences of ethnography and ethnology, investigating tribally organized mankind; and, fourth, history, the narrative and descriptive account of the evolution of civil society. Corresponding to the four great divisions of phenomena in contemporaneous society we have, first, demography, or the study of social populations; second, social psychology, and the culture-studies of comparative philology, comparative art, comparative religion, and the history of science, all of which are investigations of the social mind; third, the political sciences, devoted to a study of social organization; and fourth, such sciences of the social welfare as political economy and ethics, the scientific study of education, studies of pauperism and criminology.

Such being our conceptions of the nature of society, and of the proper analysis and classification of social facts, let us pass on to examine our concepts of the great processes of social evolution, and of the causes in operation.

We accept the evolutionist point of view, and regard all the transformations that occur within any social group as a phase of that ceaseless equilibration of energy taking place throughout the universe. Every finite aggregate of matter is in contact or communication with other finite aggregates, no two of which are equally charged with energy. From the aggregate more highly charged, energy is given off to aggregates that are undercharged, and in this process the strong absorbs, or disintegrates, or transforms, the weak. Every social group, animal or human, since time began, has been in ceaseless struggle with its material environment and with other social groups. Whatever has happened to it or within it is most intelligibly accounted for if we view the process as one of equilibration of energies, between the group and its environment, or between group and group, or between unequal and conflicting elements within the group itself.

The modes that this equilibration assumes are many.

There is, first, the external equilibration of the society with its surroundings. This gives rise to the processes of migration, in which populations move from place to place, in search of new food supplies. Social groups are thus brought into conflict with one another, and the activities of militarism are engendered.

There is, next, a process of combined external and internal equilibration. Migration is its chief manifestation, but the migration is not now one of entire populations organized for war and conquest. It is one of individuals or families, moving from land to land in search of economic opportunity or of religious or political liberty, and its consequence is that exceeding

heterogeneity of the demotic composition which is seen, for example, in the population of the United States.

There are, thirdly, the processes of internal equilibration. First among these is the differentiation of the mind of the population, consequent upon some degree of unlikeness and inequality in the responses of differing individuals to the common stimuli to which all are subjected. This is followed by the segregation of resembling products into types and classes. Secondly, there is an evolution of the consciousness of kind, with increasing attention to means of communication and association. Thirdly, there is a struggle between strong individuals and weak, between leaders and followers, between strong and weak classes. This equilibration may take one of three possible forms: (1) The subjugation and perhaps the enslavement of the weak by the strong; (2) economic exploitation; (3) the uplifting of the weak by the strong through education, justice and economic aid. The moral advance of society is a progress from equilibration through subjugation and exploitation to equilibration through uplifting, and it depends upon the broadening and deepening of the consciousness of kind.

A fourth phase of internal equilibration appears in the struggle among differing groups of the like-minded in the community. Some elements of the population are sympathetically emotional, or are alike in beliefs or dogmas. Others are alike intellectually, rationally; they attain agreement through deliberation. In every community the reasoning and the unreasoning elements are in perpetual conflict.

To the extent that the community is controlled by its deliberative element, it exhibits a policy—a more or less consistent attempt consciously made to control its destiny. In the history of human society there have been three great groups of policies, namely: (1) policies of unification—attempts to make all members of the community alike in type, in belief and in conduct; (2) policies of liberty—attempts to give wide scope to individual initiative; (3) policies of equality—attempts to prevent the disintegration of society through an excess of individual liberty. The struggle of conflicting interests in the community, which these three modes of policy represent, is yet another form of internal equilibration.

To the extent that a policy of equality is adopted, the community is democratic. Political equality, equality before the law, and some approach toward equality of economic opportunity, are the essential elements of democracy. No sooner is democracy evolved than we see a struggle between the forces that make for absolutist, and those that make for liberal, democracy. Either the majority is permitted to rule at will, or it is compelled to leave inviolate certain rights of the minority and of individuals.

The outcome of all equilibration, external and internal, is a certain relation of the individual to the social organization. In low types of society the individual literally belongs to the various social groups in which his lot is cast. He belongs to them for life. To leave them is to become an outcast. He may not leave his clan, his guild, his caste, his church, or his state. In superior types of society we discover a high degree of individual mobility combined with a marvelous power to concentrate enormous numbers of individuals in moments of emergency, upon any work needing to be done. The individual may go freely from state to state, from parish to parish, in search of his best economic opportunity. He may sever connection with his church to join another, or none at all. He may be a director to-day in a dozen corporations, and to-morrow in a

dozen different ones. The goal of social evolution is a complex, flexible, liberal organization, permitting the utmost liberty and mobility to the individual, without impairing the efficiency of organization as a whole.

On the methods of sociology remark at this time must necessarily be brief.

Dealing as we do with highly concrete materials, we place our main reliance upon systematic induction. The experimental method of induction, however, is of little avail in the scientific study of society. Although social experimenting is at all times going on, it is difficult to isolate causes or to control conditions with scientific thoroughness. Observation, therefore, and critically established records of observations made in bygone days, must be our main dependence, so far as the accumulation of data is concerned.

Yet in a field so vast, observation itself would be a fruitless toil if it were not directed by scientific rules. Canons of guidance we find in the so-called comparative and historical methods. Selecting any social fact, or correlation of facts, observed in any given society, we systematically search for a corresponding fact or correlation in all contemporaneous societies, animal and human, ethnic and civil. This search has one clearly defined object, namely, to determine whether the observed fact is a universal, and therefore an essential, an elementary phenomenon of society, and, if it is not universal, to ascertain just how wide its distribution is. By such research we discover those resemblances and differences in social phenomena that are the bases of scientific classification.

Having in this manner arrived at a scheme of classification, we use it in subsequent observation precisely as the chemist or the botanist uses the classifications that have been established in his science. We systematically look for the facts and the correlations that the classification leads us to anticipate.

In like manner, following the historical method, we search for a given social fact at each stage in the historical evolution of a given society, and thereby determine what social phenomena are continuous.

A complete scientific theory of natural causation is established only when our knowledge becomes quantitatively precise. Often the law that we seek to formulate eludes us until the correlations of phenomena have been determined with mathematical exactness. Sociology has unjustly been reproached for neglecting that attention to precision which is the boast of other sciences. The indictment of vagueness may be a true bill against individual sociologists. It is demonstrably not a true bill against sociology. It is to the scientific students of sociology that the world owes the discovery and development of an inestimably valuable form of the comparative and historical methods, namely, the statistical method. Every inductive science to-day is adopting this method. Physics, chemistry, astronomy and geology would be helpless without it. The biologists have acknowledged their dependence upon it by the establishment of a statistical journal, *Biometrica*. It is not too much to claim that the possibilities of this now indispensable method of all the sciences were first demonstrated in the epoch-making social studies of Jaques Quetelet, and that its employment in sociology has been out of all proportion to its employment elsewhere. As developed in recent years by Westergaard, the Dane; by Germans, like Steinhauser, Lexis and Meyer; by Italians, like Bodio; by Frenchmen, like Levasseur and Dumont; by Englishmen, like Charles Booth, E. B. Tylor, Galton, Bowley and Karl Pearson; by Americans, like Mayo-Smith, Weber, Norton, Cattell, Thorndike and Boas, it has become,

and will continue to be, the chiefly important method of sociology; and assuredly, in the course of time, it will bring our knowledge of society up to standards of thoroughness and precision comparable with the results attained by any natural science.

Franklin H. Giddings.
Columbia University.

*Recent Advances in the Analysis of the Earth's Permanent Magnetic Field.**

The 'earth is a great magnet' and as such is subject to the same laws which pertain to any other magnet—these are facts established by the experience of over four centuries. How and whence the earth has received its magnetism are questions we can not as yet answer, nor, in my opinion, shall we be able to answer them definitely until we have solved the problems as to the causes of the *variations* of the earth's magnetism. I firmly believe that when we have discovered the causes of the periodic and aperiodic variations, such as the diurnal variation, annual variation, secular variation and magnetic perturbations, we shall have strong hints given us as to the *origin* of the earth's magnetism. It is through the study of the *variations,* then, that we hope some day to be able to attack the problem as to the origin with some degree of success. Until this study has been completed, it is not believed that anything more than mere surmises, such as the magnetic literature contains *in quanto* can be given.

Whether the earth is a magnet like a lodestone or an electromagnet, is another question which can not as yet be definitely answered, though there are various indications that the earth's magnetization partakes of the character of both. Here again the definitive answer depends upon the successful solution of the questions as to the variations of the earth's magnetism both as to time and space.

These introductory paragraphs are intended to emphasize the proposition that if progress is to be made in the subject of the earth's magnetism, we must first make a careful and exhaustive study of the facts which are daily experiences, before attempting broad, theoretical generalizations based on more or less inadequate data permitting at the most mere qualitative tests of the deductions of theory. What are needed are the facts for *quantitative* tests. Even then, it will be found, in some instances, that more than one theory will satisfactorily explain the same facts and that a final decision must be left to future generations. However, the *facts* will remain as a permanent acquisition. *The accumulation of clean-cut facts regarding the earth's magnetism is the great task of the present generation.*

In the hope of enlisting interest in this comparatively unexplored field of scientific inquiry, it will be my endeavor to reveal some of the gaps to be filled as well as to exhibit those facts considered as safely established. It must be remembered that we are working in a field bordering on several other sciences, such as astrophysics, geophysics, geology and meteorology, so that he who wishes to become an expert must have at his command the ability to make the best and most intelligent use of the experimental facts of several of the older, recognized sciences. The physicist now-a-days has no time to attempt to master so special and comprehensive a subject as that of the earth's magnetism, with its manifold ramifications into cognate sciences, for he finds it sufficiently difficult to keep in touch with the rapid advances in his own subject. However, if the physi-

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