whose word actually was Pragmaticism; putting the spanning of the American continent by railroad one year ahead of the true date; being rather unlucky with the transcription of French phrases and names; and generally failing to distinguish, under the general rubric of Darwinism, the idea of evolution from the hypothesis of natural selection. But these, it must be said again, are the merest specks on the surface of a first-class work.

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Atmospheric Phenomena

Aurora and Airglow. Proceedings of a NATO Advanced Study Institute, Staffordshire, England, August 1966. BILLY M. MCCORMAC, Ed. Reinhold, New York, 1967. 697 pp., illus. $28.50.

The aurora, together with the more widespread but fainter upper-atmosphere emission, the airglow, is an exciting subject for study in the space age. The sun causes the aurora to be produced on earth. The magnetosphere of the earth is perturbed in some way by the particles or waves of the solar wind. The upper atmosphere is then bombarded by streams of charged particles. The atoms and molecules of the upper atmosphere are spectroscopically excited, increased ionization is produced, and the entire gas is heated. This description of the aurora suggests the broad range of physical interests that are involved in the study of this solar-geophysical phenomenon and the great distances over which it may be necessary to conduct observations.

Many of the contributions in this proceedings volume are tutorial in style and serve very well as reviews of various aspects of the subject. Sydney Chapman gives a masterly history of efforts to account for aurora and airglow, in which one may discover, for example, what were Benjamin Franklin's ideas on the aurora. Twilight and dayglow observations and theory are covered very nicely by Gadsden and by Noxon. The worldwide morphology of the nightglow is presented by Roach and Smith. There is an excellent account by O'Brien of satellite observations of the relation of particle fluxes and auroras. The theoretical interpretation of how the solar wind perturbs the magnetosphere and how the auroral particles are accelerated in the geomagnetic tail is given by Axford and by Speiser. Omholt has an excellent review of the spectroscopic excitation mechanisms in the aurora. There are many other very fine reviews on auroral and airglow theory and observations, including ideas on how electric fields may be involved in auroral excitation and accounts of how observations have been conducted from the polar cap to the equator.

This volume also contains many contributions of what must be classified as unrefereed research reports. The quality and permanent value of these papers vary. Some are reports of recent rocket observations that were carried out with definite objectives and that succeeded very nicely in producing results that more carefully define the primary electron influx producing the aurora. There are other reports, however, of rocket experiments that attempted to measure all parameters that were measurable without any apparent scientific objectives in mind.

A remarkable achievement of this volume is that such a handsome printing and editing job has appeared within a year after the institute was held. The book contains an excellent introduction to the subject matter by the editor, an interesting conference summary conducted by a panel, and finally the editor's conclusions about the current state of knowledge in the field.

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Aspects of Primate Interaction

Social Communication among Primates. Based on an international symposium held in Montreal, December 1964. STUART A. ALTMANN, Ed. University of Chicago Press, Chicago, 1967. 406 pp., illus. $15.

This interesting and important volume contains 17 chapters based on papers presented at a symposium at the 1964 meeting of the AAAS. The contributors represent a variety of disciplines: anthropology, psychology, psychiatry and neurology, linguistics, zoology. This breadth is due not only to the fact that the study of behavior naturally brings together scientists of many different backgrounds, but also to the excellent planning by the editor, who was also the organizer of the symposium. The techniques needed to reveal the roots of behavior belong to no one traditional science, and it is to be hoped that future studies of primate behavior evolve on an even broader base than that reflected in this volume.

The volume is dedicated to the memory of the late K. R. L. Hall, who died the summer after the symposium. Hall was a leader in elucidating the relations between controlled laboratory experiments and field observations. The importance of this point of view is evident in many of the papers in the volume and the discussions that follow them. The emphasis on the complementarity of the two kinds of study reflects a trend that holds great promise for the future of both.

The volume is divided into five parts. The first is on reproductive behavior and includes papers on breeding in *Lemur catta* (Jolly), reproductive cycles in baboons (Rowell), and mother-infant relations in macaques (Rosenblum and Kaufman; Jensen, Bobbitt, and Gordon), with discussion by Altmann. The second part contains three papers on agonistic behavior—in baboons (Kummer) and in rhesus (Kaufmann; Sade)—with discussion by Rioch. There are three papers in the third section, on causal mechanisms—experimental approaches (Miller), neurological aspects of vocalizations (Robinson), brain stimulation of squirrel monkeys (Ploog), with discussion by Rioch. The fourth part, on social dynamics, includes a paper on the remarkable aye-aye (Petter and Petter), one on newly acquired behavior patterns (Tsumori), and two on langurs (Sugiyama; Ripley), with discussion by Warren. The final section is on communication processes—social interaction in patas (Hall), auditory communication in vervets (Struhsaker), structure of primate communication (Altmann), with discussion by Sebeok and final editor's comments by Altmann.

The papers are too diverse to permit the book to be easily summarized or evaluated, but some major points can be made. Because, as several of the papers indicate, it is now possible to monitor internal states by brain stimulation and telemetry and to gather objective information on events in "the little black box," a new era in behavior studies has begun. These technical advances render obsolete theories of behavior which attempted to limit the study of behavior to externally observable events and considered internal events as unascertainable in principle. Further, these studies show that the notions of the brain as a *tabula rasa*

and the cortex as equipotential are equally dead. Obviously such studies are going to throw much light on questions relating to human behavior.

"Communication" is considered in a very broad way in the book—even the possibilities that sneezing, coughing, and vomiting may be forms of communication are touched on. A fundamental confusion arises where the organized social group is regarded as being identical with the system of communication; I believe that it is much more useful to view the communication system as one of the essential mechanisms by which group behavior is organized, a point of view which leads to more emphasis on the function of the message and less on the particular channel. This is particularly important in the study of nonhuman primates, where, as is pointed out by Altmann, the message may have no auditory component or, if it does, this component may be unimportant. The long discussion of design features common in primate communication leaves the reader with no clear notion as to why human language appears to be so different. Emphasis on the message clarifies this point, as the nonhuman primates can convey very little information, whereas human language by virtue of using names for environmental reference can convey a vast number of messages. Probably the greatest difference between man and the nonhuman primates is language and the anatomical structure which makes it possible. Study of the communication systems of the nonhuman primates can reveal both the fundamental differences and the importance of human language.

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Theoretical Battles Waged and Won

Electrons, Ions, and Waves. Selected works of WILLIAM PHELPS ALLIS. SANBORN C. BROWN, Ed. M.I.T. Press, Cambridge, Mass., 1967. 452 pp., illus. $20.

In this volume Sanborn C. Brown has collected some of W. P. Allis's theoretical papers to commemorate his colleague's new appointment as professor emeritus at M.I.T. The grapevine has it that this task was accomplished in the greatest secrecy just in time for formal presentation on a most festive evening when wine, women, and song abounded.

Allis battled the Boltzmann equation long before the modern era of plasma physics dawned on us, and most of those armchair generals who like to relive battles at their desks will find, upon reading *Electrons, Ions, and Waves,* an easy answer to the question of how they would have fared in this intellectual struggle: The Boltzmann equation would have won. Allis, more courageous and talented than many, has managed to fight the inscrutable equation to a draw: Involved partial differential equations, in anywhere from one to seven independent variables, are handled by extensions of the perturbation kinetic method that Lorentz applied to electron motion in metals. The list of problems solved is impressive, and includes, among others, a determination of the velocity distribution of the electrons drifting and diffusing in a Townsend apparatus and a theoretical treatment of high-frequency electrical breakdown in gases. The Townsend problem involves an approximate solution of the space-dependent Boltzmann equation, a boundary-value problem which has not been exactly solved to this day. Evaluation of breakdown potentials requires a precise determination of the high-energy tail of the electron velocity distribution when both elastic and inelastic collisions with real neutral atoms play an important role. It is no surprise then that this collection includes also some of the most detailed modern calculations made on the scattering loss of charged particles from magnetic-mirror confinement systems. These are all challenging problems in kinetic theory.

During the 1950's Allis tackled the ambipolar diffusion problem by a mixture of analytical and numerical techniques. Anyone who has ever tried to subtract slightly differing plasma electron and ion charge densities without ending up with 10^6 volt/cm will appreciate that his paper on "The Transition from Free to Ambipolar Diffusion" is a classic. According to the editor's explanatory remarks such subtraction continues to be a problem in this field, and led to the inclusion of a recent unpublished paper, "On the Ambipolar Transition."

Many have been dismayed by the jungle of misnomers, semantic confusion, and redundancy in the literature of wave propagation in plasmas. Toward the end of the 1950's Allis decided to do something about it. In the period that followed, the notions extraordinary wave, $m/M = 0$, right-hand polarized, left-hand circular, ordinary, cut-off, $M/m >> 1$, resonance, and the like went into the grinder and reappeared as principal lines and as phase velocity curves on what has come to be called the CMA (Clemmow-Mullaley-Allis) diagram. Some approximations had to be made: Collisionless damping fell by the side, and most other thermal effects were ignored. This upset some of the purists, but when all is said and done Allis's classification of waves has proved its worth, especially to the experimentalists who now frequently interpret wave propagation through nonuniform plasmas with the help of such diagrams. About one-fourth of this volume is devoted to these subjects in wave propagation. Here too, in his paper "Electron Plasma Oscillations," we find Allis (1958) deriving a Landau damping rate, correct apart from a factor $16\pi^2$. Present-day readers may be upset to find that his derivation is based on a calculation of the work electrostatic waves do on the trapped electrons, a nonlinear effect, when the Landau derivation was based on linear phenomena. The resolution of this difficulty is left to the reader, who is encouraged to remember the emotions Landau damping generated ten years ago.

These selected works mirror the characteristic style with which one man has influenced many colleagues and students over the past four decades. For his editorial efforts in collecting these works Brown deserves the thanks of all who wish Allis well.

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Why Science Succeeds

The Organization of Inquiry. GORDON TULLOCK. Duke University Press, Durham, N.C., 1966. 242 pp., illus. $5.50.

In *The Organization of Inquiry* Gordon Tullock attempts to explain how the apparently nebulous structure of scientific activity has enabled scientists to produce a coherent and cumulative body of knowledge. He begins his treatment with an analysis of the social organization of science and goes on to consider the question Why in-