ranging from some impairment in formal reasoning to the more severe breakup of operativity. On the basis of observations of prepsychotic children and their tendency to assimilate stimuli in an egocentric manner, it becomes obvious that development of operativity depends not only on internal regulations, but requires a motivational force directed toward the adaptation to reality. These studies have supported the general dictum that pathological phenomena of thought become more comprehensible when analyzed in developmental perspective. They have shown that operational construction, although it directs the progress of symbolism, is relatively independent of its symbolic support. The fact that cognitive operations disintegrate in an order that inverts their evolution suggests that development of operativity is an integrational process.

Certain difficulties in relating the Piaget system to clinical problem areas were explored by E. P. Dulit (Albert Einstein College of Medicine). The two specific issues he raised had to do with: the relative lack of emphasis in Piaget's work on the concept of heterogeneity, that is, the coexistence at one time of functions on more than one level; and the need to differentiate between the static imagery of which Piaget speaks and the creative role of imagery in the life of the adult. Both issues appear to derive from Piaget's primary interest in genetic epistemology, rather than from totality of the child's experience. Dulit took exception to Piaget's analogy of motivation as the motor which runs a movie camera; he pleaded for understanding of the kind of model that would enable us to understand more adequately how motivational and cognitive processes interdigitate.

E. H. Auerswald (Wiltwyck School for Boys) spoke of the relevance of the conceptual scheme of Piaget and Inhelder to the dysocial behavior traditionally considered as disorders of ego: crime, delinquency, alcoholism, and drug addiction. One prominent finding from studying the families of delinquents was the very striking deficit in conceptualization common to all members of a family. Parents were often unable to express well-differentiated concepts of space, weight, size, volume, or shape; they were equally lacking in concepts that allow for the organization of time into sequential events. The children in turn live in the actions of the moment, not in thought, as if they had failed to develop the cognitive tools to enable them to reason before acting; they also appear to lack capacity to generalize experience by analogy and to categorize past experience in a way that makes meaningful the relations between past, present, and future. This appears to be a situation in which social phenomena account for the deficit in operativity.

B. Kaplan (Clark University) briefly compared the genetic psychology of Piaget and the comparative developmental approach of Werner, emphasizing the latter's early interest in psychopathology and his search for underlying archetypal patterning that applies to the pathological as well as to the normal. Multiple modes of personality organization are comprehended under a unitary principle, and pathology may be ultimately resolvable into two archetypal forms: a pathology of the understanding and a pathology of the imagination.

Shands, despite admiration for the Piaget system, also indicated its shortcomings in terms of meaning to the clinician. He referred to it as an ice palace of marvelous theoretical insights which manages to freeze the people out rather comprehensively. Piaget's studies are specifically oriented along developmental lines, whereas the problems confronting the clinician involve understanding of the particular maneuvers into the future that characterize the behavior of patients.

MONTAGUE ULLMAN,
Program Chairman

Pest Control: Chemical, Biological, Genetic, and Physical Means

The 1964 meeting sponsored by Section O (Agriculture) of the American Association for the Advancement of Science was held on 27, 29 and 30 December 1964. Because of continued public interest in pest-control problems, a symposium consisting of six half-day sessions was developed so that leading authorities in the field could discuss the merits and potentialities of the various means whereby pests, both invertebrate and vertebrate, might be controlled. Of the various methods currently employed for the control of pests, conventional type pesticides constitute the chief means for controlling pests of agricultural importance.

The problem we face in the use of pesticides for the control of the many pests that affect our economy, our health, and general well-being can be briefly stated by quoting a paragraph from a special address delivered by Nyle C. Brady (U.S. Department of Agriculture):

> We cannot live without pesticides in this intensely developed man-made society of ours. We could not maintain our agriculture, our health, or our present high levels of comfort and living. But, we are finding it increasingly difficult to *live* with pesticides.

The recognition that we must maintain effective pest-control procedures and at the same time strive to achieve control with a minimum of adverse side effects to man and his environment has led to an intensification of research efforts on more selective chemical pesticides and on various other approaches to pest control. Such research emphasizes the development of procedures that will avoid or minimize certain risks and side effects that are inherent in the use of broad spectrum pesticides.

It is generally recognized that biological agents, including parasites, predators, and disease organisms, play major roles in keeping many potential pests under natural control. How to use these natural control agents more effectively was the subject of discussion in two of the six sessions in the symposium. The application of genetic principles in the breeding and selection of crop varieties which resist or tolerate attack by pests represents another of the important means of pest control, especially diseases of agricultural crops. Accordingly, several topics dealing with breeding of plants and animals for resistance to pests and diseases were included. Suitable equipment is an essential part of the effective and efficient use of pesticides, and for applying cultural measures for the control of weeds and other pests. Thus engineering principles play a vital part in the application of pest control measures. Insects and other pests respond to various physical phenomena, such as light, other electromagnetic radiations, and sounds, thereby offering opportunities for pest control by such physical forces. One of the six sessions was devoted to a consideration of physical means for pest control.

The symposium brought together outstanding scientists having competence in several broad scientific dis-

ciplines. The scientists included entomologists with different areas of specialization, plant physiologists, chemists, plant and animal pathologists, nematologists, plant and animal geneticists, wildlife biologists, and agricultural engineers. The problems of pest control are so varied and complex it is essential that there be interdisciplinary cooperation and coordination of efforts by scientists in the different disciplines and in various agenices in order to obtain the information required to develop and put into practice effective and acceptable pest control measures. This was pointed out in a special address delivered by Robert Glen (Canada Department of Agriculture, Ottawa).

In considering the role that pesticides will play in the future and the kinds of pesticides that will meet requirements for both effectiveness and safety, members of the panel on chemical means of pest control, led by A. W. A. Brown (University of Western Ontario, Canada) were in full agreement that pesticides of the future must possess a high degree of selectivity in action against the target pest species. This was the central theme of the reports by R. L. Metcalf (University of California) who discussed insecticides; W. C. Shaw (U.S. Department of Agriculture) who discussed requirements for herbicides of the future; and W. W. Dykstra (U.S. Department of the Interior) who spoke on the role of chemicals for the control of vertebrate pests. Selectivity in action might be achieved by developing chemicals that possess a high degree of specific action on the part of the toxicants for pest species to be controlled or by achieving a high degree of selectivity in the placement and use of the chemicals employed. As pointed out by W. M. Carleton and R. D. Brazee (U.S. Department of Agriculture), more basic information on the behavior of particles and improvements in equipment for efficient application of pesticides could contribute materially to safer use of pesticides. G. L. McNew (Boyce Thompson Institute for Plant Research) emphasized the need for basic research on the mode of action of chemicals in the plants so that materials will be more versatile and adroit in their effect in the control of plant diseases than those now in use. D. E. Howell (University of Oklahoma), an authority on external parasites of livestock, pointed out the need for selectivity in action of insecticides against the parasite without harming the host or without leaving residues in the animal tissues. The importance of nematodes in plant production was related by J. M. Good (U.S. Department of Agriculture). He reviewed the progress that has been made in the development of nematocides that will effectively control those pests, the importance of which are just now being fully recognized.

R. L. Doutt (University of California) presided over the two sessions devoted to a consideration of pest control by biological means. Insect parasites and predators play major roles in regulating the abundance of pest species. B. P. Bierne (Canada Department of Agriculture) outlined ways in which the natural biotic agents might be made more useful. The great potential that microbial agents, especially the viruses, can play as highly effective and safe ways to control insects was discussed by A. M. Heimpel (U.S. Department of Agriculture). According to G. C. Papavizas (U.S. Department of Agriculture) biological agents might also be expected to play more important roles in the future for controlling plant diseases and nematodes. L. A. Andres (U.S. Department of Agriculture) discussed the role that insects and other natural enemies can play in the control of certain noxious weeds.

The session on genetic means of pest control was led by M. G. Weiss (U.S. Department of Agriculture). The substantial progress made over the years in meeting plant disease problems through the efforts of plant breeders and plant pathologists was discussed by R. M. Caldwell (Purdue University), one of the leading authorities in this field. He reviewed the progress in plant disease control by genetic means, which has resulted in savings of hundreds of millions of dollars annually to our agricultural industry. The opportunities for further progress in this desirable approach to plant disease control was stressed. R. H. Painter, the nation's leading authority on plant resistance to insect damage, shared the enthusiasm of Caldwell and cited examples of outstanding progress in the development of plant varieties which resist damage by insects. A. E. Kehr (U.S. Department of Agriculture) also cited a number of successes in meeting plant nematode problems through plant breeding for resistance or tolerance to these destructive pests.

The many factors that must be considered and weighed in determining the role that animal breeding for resistance to diseases and parasites might play in meeting disease and pest problems was discussed by James Smith, who delivered the paper on this subject prepared jointly with R. E. McDowell (U.S. Department of Agriculture).

The symposium on the various means of dealing with pest problems in the future included reports of recent progress on various new and novel ways to control or regulate pest populations. Morton Beroza (U.S. Department of Agriculture) cited examples of recent success in employing naturally occurring or synthetic attractants that are highly specific in attracting insects. Many insects produce natural pheromones that attract one sex to the other for reproduction. Recent advances in chemical technology offer new opportunities for extracting and identifying and eventually synthesizing these natural, highly active and highly selective materials for use in insect detection and control. The sterility principle of pest control offers a new approach that could lead to practical ways to control certain insects. The progress that has been made and the opportunities for the future in applying this principle for insect control or eradication was discussed by L. D. Christenson (U.S. Department of Agriculture). This new principle of pest control may also have application in regulating the abundance of vertebrate pests. D. K. Wetherbee (Massachusetts Cooperative Wildlife Research Unit) discussed the progress in developing geneticides and other reproductive inhibitors as a means of regulating the rate of reproduction in populations of birds, mammals, and other vertebrates that may become pests in various situations.

Electromagnetic energy is now playing only a minor role in pest control. However, as brought out in the session on physical means of pest control, led by Ronald Paugh (General Electric Company), the use of sound, especially the use of recordings of distress calls, is being employed for repelling certain birds from specific areas. This was brought out in the paper presented by S. O. Nelson (U.S. Department of Agriculture). He also discussed the role that gamma and other radiation might play in the future for destroying insect pests in stored products. The role of light ra-

diations for insect detection and control was reviewed by F. R. Lawson, who also reported on research conducted by him and his associates of the U.S. Department of Agriculture. The highlight of this report was the success achieved in reducing populations of the tobacco hornworm by large-scale trapping experiments in which several hundred black light traps were used over an area of more than 100 square miles (260 km^2). Another observation reported by Lawson which may have great significance was the marked increase in catch of male hornworm moths in light traps when unmated female hornworm moths were caged in close proximity to the light traps. Electromagnetic radiations in the infrared and far red regions of the spectrum may provide the chief means of communication between insects of a given species in connection with reproduction, according to a theory advanced by P. C. Callahan (U.S. Department of Agriculture). He also expressed the view, with supporting data, that radiations given off by host plants or animals may represent the means whereby certain insects locate their host plants or animals. The theories advanced by Callahan should stimulate research on the influence of electromagnetic radiations on insect responses and behavior.

The symposium on pest control by chemical, biological, genetic, and physical means was broad in scope. Twenty-four topics were presented. These topics encompassed the research efforts now under way to develop almost every conceivable approach to the control of pests. The material presented clearly showed the desire of scientists with many agencies to obtain new information which will serve as a basis for maintaining and improving on the great advances that have already been made in meeting pest problems and at the same time assuring the achievement of this objective without undue risks to man and his environment. There is reason for optimism that significant progress can be expected in the practical development of various alternate ways to control pests. In all probability many major pest problems will also be met more effectively and safely in the future by properly integrating different systems of pest control.

E. F. KNIPLING, *Chairman*

Reports of Sections and Societies

General Sessions

Possible Meteoric or Lunar Influences on Meteorological Phenomena

The interdisciplinary symposium on possible meteoric or lunar influences on meteorological phenomena (sponsored not only by the Physics (B) and Astronomy (D) Sections of the AAAS but also by the American Geophysical Union, the American Meteorological Society and the American Astronomical Society) advanced convincing evidence that (i) active freezing nuclei, with important meteorological consequences, are present in the lower atmosphere in spectacularly varying quantities, and they descend to the lower atmosphere from space or at least from an abundant reservoir at heights above 25 km, and (ii) lunar tide-producing forces manifest themselves as small but statistically significant changes in heavy rainfall frequencies at widely separated terrestrial stations.

E. Keith Bigg described experiments to ascertain the origin and properties of freezing nuclei important in many cloud physical processes. The original "Bowen hypothesis" on the influence of meteoric dust on rainfall called for 10-μ particles capable of falling from high to low levels of the atmosphere in about 30 days. Bigg's work on actual particle collection reveals, instead, particles largely of submicron size which vary abruptly in concentration by factors of as much as 1000 times. The "ice nucleus storms" show no simple or consistent relation to local dust sources or small-scale surface weather conditions, nor are there decreases in numbers of freezing nuclei evident at greater heights. In fact, there is some evidence for substantial increases in volumetric concentrations above 27 km, and thus above the "ammonium sulfate layers" of Junge where freezing nuclei appear likely to be coated over with the soluble sulfate, and rapidly destroyed in freezing effect unless they can be transported rapidly downward.

Recent Australian experiments seem to suggest that just such rapid vertical transport may indeed be responsible for the large pulses of freezing nuclei often found at lower levels.

Glenn W. Brier presented results of work done in collaboration with Donald A. Bradley and Max A. Woodbury which convincingly demonstrates a small but real influence of lunar tides on the frequency of occurrence of heavy rainfall. Using data from 1871 to the present, these painstakingly careful studies seem, on very conservative statistical grounds, to confirm the reality of an effect tending to produce greater frequency of heavy rainfall a few days after new moon and full moon in the lunar month—for all months and locations. Brier cautioned, however, that the effects involved represent only small perturbations on the average variability of rainfall. Thus, no matter how well established, they cannot at present add more than a minor additional factor to the prediction, for any given day, of the prospect of rainfall or for the magnitude of the expected fall. They are, however, of great significance to the understanding of the mechanism of large scale meteorological phenomena.

WALTER ORR ROBERTS,
Program Chairman

Symposium on Medical Geology and Geography

Seldom can five people with such different backgrounds enjoy exchanging their experiences and points of

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E. F. Knipling

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