of biology brought up to date year by year and provided with the thoroughly adequate types of indexes so carefully worked out by Dr. J. R. Schramm is a matter which can not be lightly turned aside.

For the sake not only of its value to science, but also of its educational and reference value to students and intelligent citizens generally, it is to be hoped that the future of *Biological Abstracts* may be assured.

FREDERICK V. RAND

WASHINGTON, D. C.

SOCIETIES AND MEETINGS

A SYMPOSIUM ON THE ALGEBRA OF GEOMETRY AND RELATED SUBJECTS

A SYMPOSIUM on the algebra of geometry and related subjects was held at the University of Notre Dame on February 11 and 12. Algebra of geometry, not to be confused with algebraic geometry in the classical sense, is a foundation of geometry starting with one class of elements (points, lines, planes, etc.) and two undefined operations called joining and intersecting of elements. It is based on a few simple formulas about these operations, similar to and partly identical with the formulas about addition and multiplication on which the ordinary abstract algebra is founded. That is why mathematicians in Vienna called the calculus which they developed from these assumptions algebra of geometry. In an algebraic way, one can define when an element is part of another element, and then make precise the famous initial words of Euclid "point is that which has no parts." Lines, planes and n-dimensional elements can be defined and the ordinary axioms of geometry be deduced.

In the first of the four meetings, Dr. Marshall H. Stone, of Harvard University, presented a paper on the applications of Boolean algebra to topology. Boole's algebra of logic can be obtained as a special case of the more general algebra of geometry. Mr. Garrett Birkhoff, of Harvard, who, in this country, discovered and developed the algebra of geometry under the name of theory of lattices, presented new applications of his theory to partly ordered function spaces. Dr. E. W. Chittenden, of the University of Iowa, conducted the discussion.

The second meeting, under the direction of Dr. R. T. Hildebrandt, of the University of Michigan, dealt with applications to the theory of groups. Dr. O. Ore, of Yale University, spoke about what he calls structures of groups, *i.e.*, systems of subgroups of a group, which may be joined and intersected like points, lines and planes in geometry. Dr. Saunders MacLane, of the University of Chicago, presented an application of lattice theory to the structure of fields of numbers. Dr. James K. Senior, of the University of Chicago, mentioned some unsolved problems concerning structures of groups, whose solution would be of importance to organic chemistry.

The following morning, Dr. John von Neumann, of the Institute for Advanced Study, Princeton, presented his continuous geometry, in which there are no points and the dimension of the different objects assumes all values between zero and one. Dr. Karl Menger, of the University of Notre Dame, spoke about the algebra of affine geometry developed by F. Alt and himself. Pointing out the desirability of similar algebraic foundations for non-Euclidean and other geometries. The discussion was directed by Dr. I. A. Barnett of the University of Cincinnati.

The last meeting, conducted by Rev. H. Kenna, C.S.C., of the University of Notre Dame, dealt with algebraic questions. Dr. A. A. Albert, of the University of Chicago, spoke about applications of division algebras to geometry. Canon Lemaître, of Notre Dame and Louvain, presented a paper applying hyper-complex numbers to Eddington's interpretation of the equation of Dirac. Dr. Emil Artin, of Notre Dame, gave new proofs of algebraic theorems containing as a special case the theorem of Wedderburn which, applied to geometry, shows that in a space consisting of a finite number of points the law of Pascal is a consequence of the law of Desargues.

On the first evening, Dr. Edward V. Huntington, of Harvard University, gave a general lecture on the method of postulates, entitled "The Duplicity of Logic."

The meeting was attended by a group of more than fifty visitors from various parts of the country.

KARL MENGER

UNIVERSITY OF NOTRE DAME

REPORTS

INDUSTRIAL RESEARCH INSTITUTE

FOR sometime now the research executives of middle-sized industrial corporations, well known for their advanced position in research in their respective fields of industry, have felt the need of an organization in which they could discuss common problems principally concerned with organization and administration of research laboratories.

To determine on the factual basis of a survey and questionnaire to what extent the need for such an organization was realized by directors of research, the Division of Engineering and Industrial Research of the National Research Council sent out 500 letters to an arbitrary selection of industrial research laboratories listed in NRC Bulletin No. 91, representative of many fields of industry and all major industrial areas of the country. Over 400 letters have been received in the survey to date and of six suggested services, one on an information bureau on problems of administration, organization and operation of research laboratories was voted as most important by the majority of those making reply. The most pressing problems in the front of the minds of research executives in industry to-day, irrespective of field of industry or geographic location in the country, are the selection, training, handling, incentive and bonus plans for research personnel. In informal discussions another facet of the perplexing problem of securing adequately trained industrial research workers, several directors of research suggested that specifications based on actual experience be drawn up by a committee of industrial research directors and placed before the Society for the Promotion of Engineering Education and key technical colleges and universities. The problem of hardly secondary importance relates to all phases of organization, administration and operation including such questions as the construction and control of budgets, relation of research laboratory to other departments of an industrial company, the coordination of research activities with market studies and sales promotion, and quantitative measurements for evaluating the value of research both in short term and long term periods.

One significant and primary fact stands out above all in the development of plans for the Industrial Research Institute as they developed thus far. A Steering Committee appointed by Chairman Vannevar Bush and consisting of: Robert B. Colgate, Colgate-Palmolive-Peet Company; H. W. Graham, Jones and Laughlin Steel Corporation; Donald Bradner, Champion Paper and Fibre Company; H. Earl Hoover (D. G. Smellie alternate), The Hoover Company; G. E. Hopkins, Bigelow-Sanford Carpet Company; Oliver Kamm, Parke, Davis and Company; O. A. Pickett, Hercules Powder Company; John M. Wells, American Optical Company; Maurice Holland, Division of Engineering and Industrial Research, National Research Council; met for preliminary discussions of the need for the Institute and the type of services which it could render. Two weeks later the first general organization meeting was held in the board room of the American Society of Civil Engineers, Engineering Societies Building, New York, at which representatives of more than 40 definitely interested corporations participated, indicated and confirmed the findings of the Steering Committee that there were common problems, that they were primarily concerned with improving the general efficiency of research laboratory operation and increasing the return on the research dollar investment. The research executives participating at this meeting agreed that the tangible and direct benefits of the institute in the order of their importance as the plans had developed to date indicated that personal contacts, the opportunity for frequent and informal discussion of common problems was of first importance. Round table conferences on specific subjects participated in by small groups and supplemented by field studies and laboratory visits was a second important service. Third, the external relations of industrial research laboratories, particularly with universities, with other industrial laboratories, with research agencies in the field of pure science might well call upon the pooled experience of all the members of the institute and the evaluation of the operations of a single laboratory against those in the cooperative group.

The institute is primarily designed to serve the middle and small sized industrial research laboratories. Of the 1,600 laboratories listed in Bulletin No. 91, 1,100 have 10 or less personnel, over 700 have less than 5. This is the industrial backbone of research in American industry. This is the representative cross section which the institute hopes to serve. The institute will concern itself primarily with problems of method in research itself, not problems in electronics, chemistry or biology; not problems in soap-making, steel-making or textile weaving; not problems in materials testing or process development. These are the general problems in the efficient conduct of research for whatever purpose and in whatever field. The discussions of interested prospective members of the institute thus far have clearly demonstrated that they are effectively and adequately served in the technical and scientific aspects of their activities by existing agencies. A report prepared by the Engineering Societies Library, however, indicates that the objectives and specific services as outlined in the institute *program for the research laboratory as an institution* is not duplicated by any existing organization.

The institute will not duplicate the services of any existing organization. On the contrary wherever and whenever it appears that any proposed task can be better done by or through another organization, it will turn over that job to the hands best fitted to perform it. The institute as now envisioned will not follow the

conventional pattern of association or society organization and functions, it will attempt to provide "fluid mechanisms"—stripped of all formalism or meaningless detail—for the most effective interchange of information and cooperation in current and vital services at the least possible cost in time, effort and expense.

At an executive committee meeting held in the Engineering Societies Building on March 25, Robert B. Colgate, vice-president of Colgate-Palmolive-Peet Company was elected chairman of the executive committee and Mr. H. W. Graham, general metallurgist, Jones and Laughlin Steel Corporation vice-chairman. The executive committee will serve as a committee of the National Research Council by appointment of Chairman Bush during the formative and development period of the institute. Later it is expected that the institute will be incorporated as a membership non-profit organization under the laws of the State of New York. In the meantime the Division of Engineering and Industrial Research of the National Research Council has offered its facilities, the services of its staff, and its technical resources and contacts during the experimental period. Maurice Holland, director of the division will serve as executive officer of the institute.

MAURICE HOLLAND,
Director, Division of Engineering and Industrial Research, National Research Council
NEW YORK,
MARCH 29, 1938

SPECIAL ARTICLES

SUBLETHAL EFFECTS OF LONG WAVE-LENGTH ULTRA-VIOLET

IN work previously reported on the effect of long wave-length (3,130 and 3,660 Å) ultra-violet radiations upon protozoans[1] large dosages were found to have no immediate visible effects and the animals so irradiated divided when fed and conjugated when starved following generous feeding. In some cases, however, division seemed retarded and the possibility of slight sublethal effects was suggested, but control of the test material was inadequate for accurate work. Subsequent studies of the effects of short wave-length ultra-violet rays upon cleavage of the eggs of the sea urchin (*Strongylocentrotus purpuratus*) and upon excystment of *Colpoda duodenaria* cysts indicated that these were more sensitive and reliable test materials. The effect of long wave-length ultra-violet radiations upon cleavage and excystment of these forms was therefore studied.

The apparatus was similar to that previously employed.[1] The methods for handling Colpoda cysts were similar to those described by Taylor, Brown and Strickland,[2] by whom the materials used here were generously supplied. The excystment studies reported here were made at $20 \pm 0.3°$ C. The methods for handling sea urchin eggs will be described in detail elsewhere. The temperature of the room in which the work on the sea urchin eggs was carried out was $15 \pm 1°$ C.

In a representative set of experiments after a dosage of 400 ergs/mm² at λ3,025Å, which is at the long wave-length end of the lethal spectrum, the 8-celled stage in cleavage of the sea urchin egg was reached about one hour later than in control cultures. While such small doses with λ3,130Å usually had no noticeable effect upon the cleavage rate, a dosage of 3,200 ergs/mm² caused approximately an hour delay in the appearance of the 8-celled stage. With a dosage of 12,600 ergs/mm² the retardation was 2 hours. While in all the above cases a delay was still discernible at the time blastulation and gastrulation occurred, plutei normal in appearance were formed from all the eggs, retardation being no longer observable.

Following irradiation of eggs with λ3,660Å slight retardation was noticeable only after a dosage of 40,000 ergs/mm², but even after a dosage of 74,500 ergs/mm² the retardation did not become conspicuous enough to measure accurately. No retardation was observable at the time of blastulation or thereafter, observations being made until the pluteus stage was reached.

In no case were eggs irradiated at these wave-lengths with less than the retarding dosage observed to cleave more rapidly than controls, the cleavage rate in such cases being equivalent to that of the controls.

Excystment time of Colpoda cysts (time elapsed from the moment the cysts are placed in an excysting medium to the exit of the animals from the cysts) was increased by irradiation with λ3,025Å, thus in a representative set of experiments a dose of about 3,000 ergs/mm² caused an increase in time of 50 per cent. excystment of about ¾ hour, a dose of 8,000 ergs/mm² an increase of 3¾ hours (time of 50 per cent. excystment of controls: 132.3 ± 5.9 min. in the experiments reported). A dose of 3,000 ergs/mm² at λ3,130Å, however, failed to increase excystment time, and ten times this dose caused an increase of only about 1/3 hour. Prolonged irradiation with λ3,660 even after dosages of 100,000 ergs/mm² had been given produced no increase in excystment time, the irradiated animals excysting at the same time as the controls.

[1] Giese and Leighton, SCIENCE, 81: 53, 1935.
[2] Taylor, Brown and Strickland, *Jour. Cell. and Comp. Physiol.*, 9: 105, 1936.