SCIENCE

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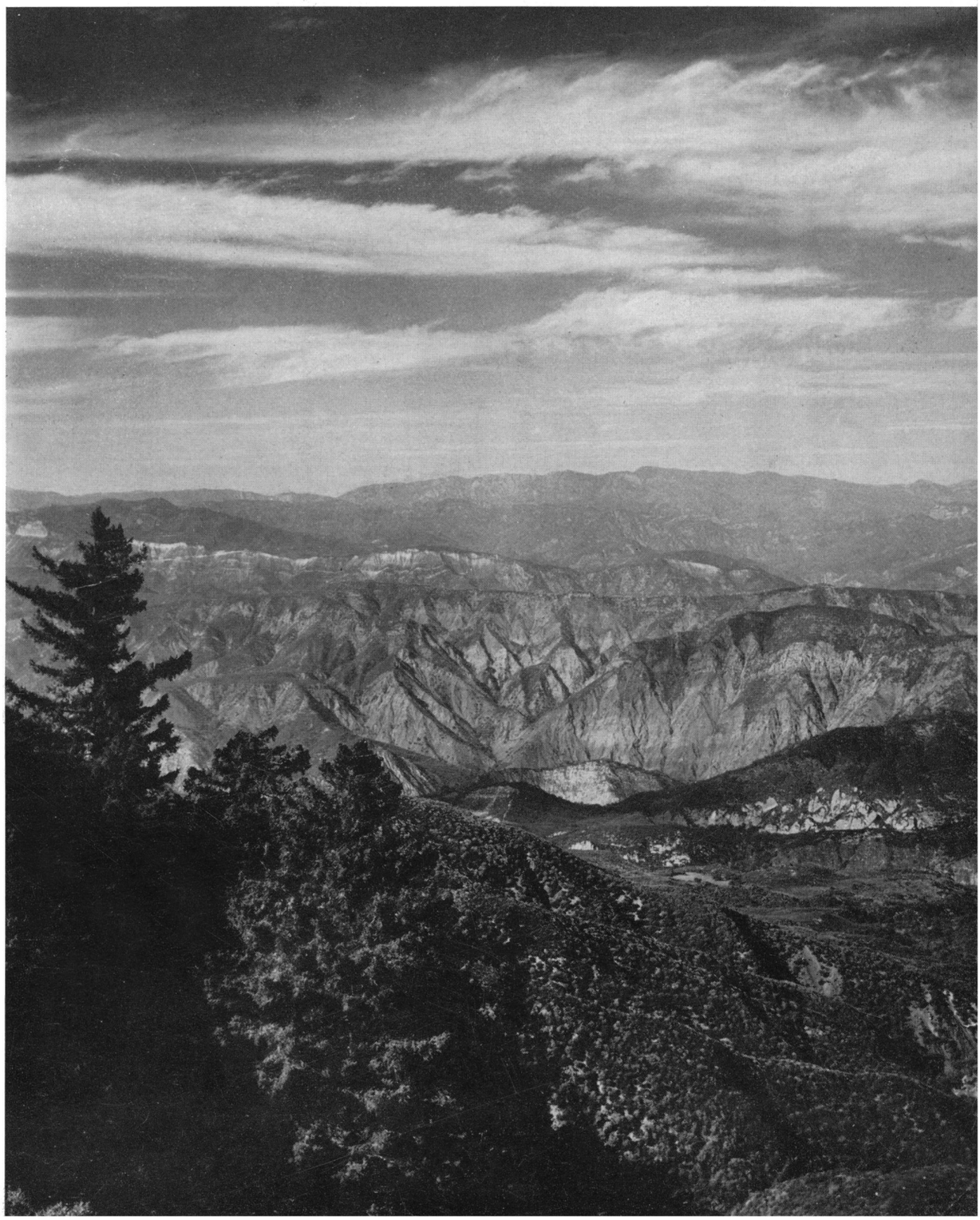

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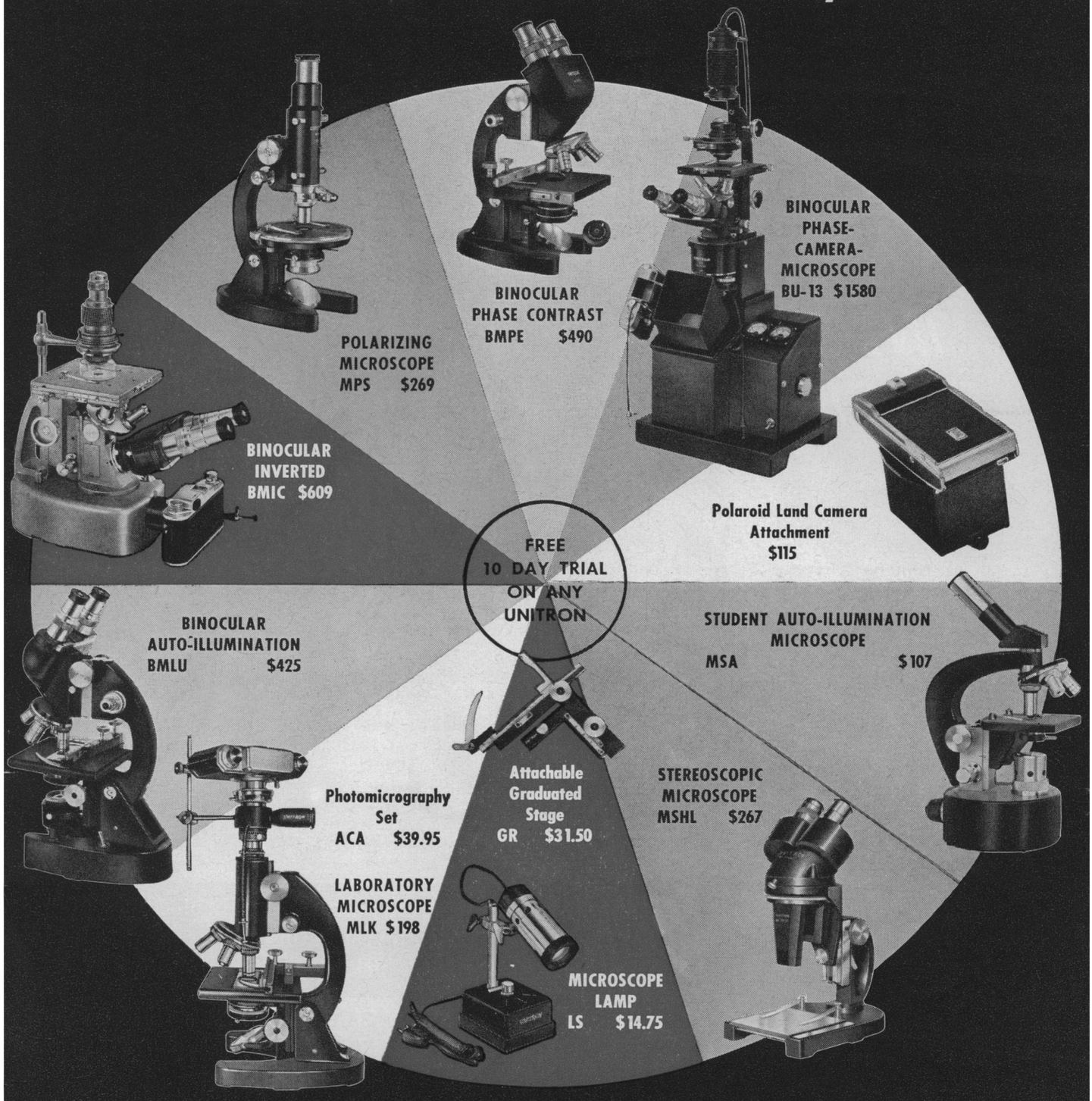

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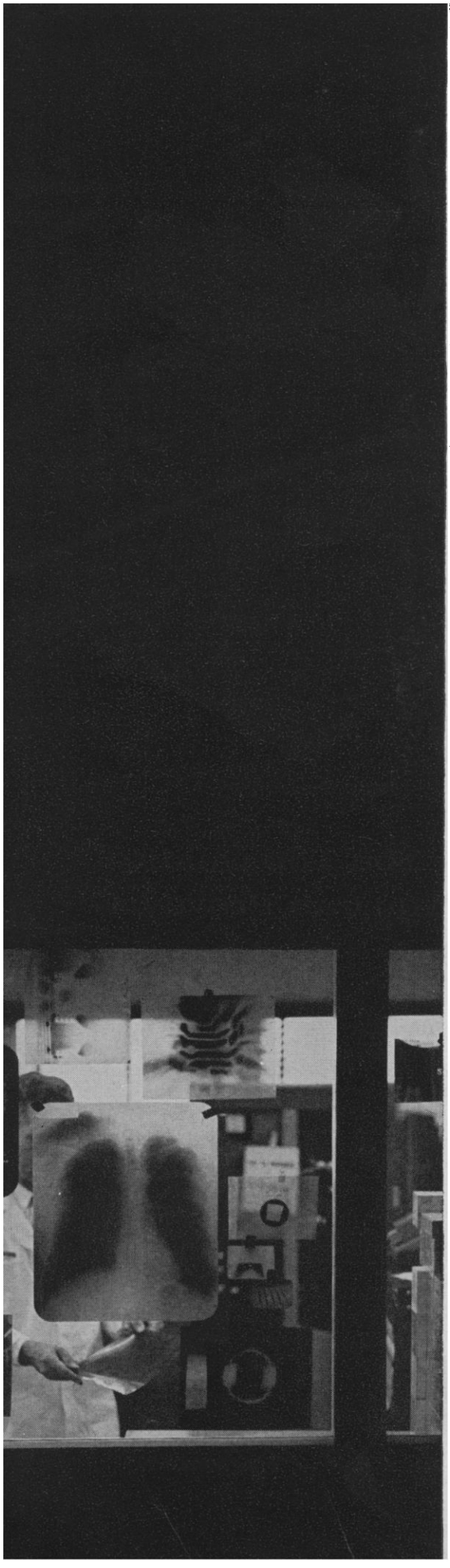
SCIENCE

Cover

Terrain of Santa Barbara County, California, where a randomized experiment on the effectiveness of cloud seeding has been under way since 1957. Part of Los Padres National Forest. See page 1073. [David Muench]



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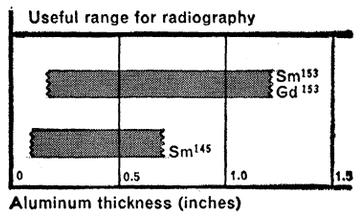
Warren, Michigan



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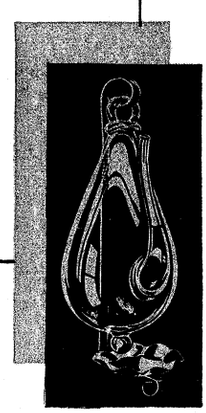

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Letters

Plotting Titration Data

The method of plotting titration data suggested by B. H. J. Hofstee [*Science* **131**, 39 (1960)] is open to question because the value of one of the variables appears in both the ordinate and abscissa. The suggested form of his Eq. 1,

$$P = (XY) + K(XY)/(Y) \qquad (1)$$

does not separate the two variables. A preferable way to plot the data would be

$$1/(XY) = 1/P + (K/P)/(Y) \qquad (2)$$

Thus a plot of $1/(XY)$ versus $1/(Y)$ gives a slope of (K/P) and intercept of $1/P$.

This method of plotting is used in the treatment of closed-chamber data on gun propellants. In that case the maximum pressure P_m is related to the density of loading Δ, the force λ, and the covolume η, by the relation

$$P_m = \Delta\lambda/(1 - \eta\Delta) \qquad (3)$$

Observed values of P_m obtained through varying Δ are easily treated by rearranging Eq. 3 to give

$$1/\Delta = \lambda/P + \eta \qquad (4)$$

so that a plot of $1/\Delta$ versus $1/P$ gives a slope λ and intercept η.

One effect of graphs that contain one of the variables in both ordinate and abscissa is to give a smoothing effect that conceals real variability which may exist. The case of nonlinear relations plotted on logarithmic paper is even more important, since the combining of variables may suggest exponents of the terms that are different from those found when the variables are properly separated.

JAMES H. WIEGAND
4032 Las Pasas Way,
Sacramento, California

Wiegand's Eq. 2 is one of the three possible linear nonlogarithmic equations for the graphical determination of the kinetic constants of a reaction of the type

$$X + Y \rightleftarrows XY$$

whereby X is titrated with Y. The three forms were first proposed (but not published) by Woolf (see *1*) for the estimation of the maximal rate and the Michaelis constant of an enzymic reaction. The plot of $1/(XY)$ versus $1/(Y)$ was first applied to actual cases by Lineweaver and Burk (*2*).

The latter procedure, like the one in which (Y) is plotted versus $(Y)/(XY)$, has the disadvantage that it overemphasizes experimental points on one side of the curve at the cost of those on the other side and thus tends to produce a lopsided stretching that obscures experimental errors and deviations from theory (*3-5*). Furthermore, it does not allow the summation of the curves of simultaneous reactions involving Y (*4*, *6*).

The (XY) versus $(XY)/(Y)$ plot, not inverted with respect to (XY), does not have these disadvantages. Like the semilogarithmic plot of (XY) versus pY, it is symmetrical with respect to the "halfway point" corresponding to K. It allows all the data between $(Y) \rightarrow 0$ and $(Y) \rightarrow \infty$ to be plotted on a finite scale between the two limiting values $P = (X) + (XY)$ and P/K that are given by the intercepts with the co-ordinates. The noninverted plot also demonstrates more clearly whether the data justify such extrapolation.

The fact that the two variables are not separated on the co-ordinates does not detract from the value of the plot, at least not when (Y) is known accurately, as, for instance, in the case of hydrogen ion concentration in acid base titrations and the substrate concentration in isolated enzyme systems, for which the plot has been recommended. In such cases the experimental points may be placed on pre-established lines through the origin corresponding to the various values of (Y). Errors in the measurement of (XY) simply displace the experimental points along such lines, which, in fact, represent a separate scale for (Y). The points can be expected to lie in a zone that, in contrast to the case of the $1/(X)$ versus $1/(XY)$ plot, runs parallel to the theoretical curve (*5*).

In cases where the error in the measurement of both (Y) and (XY) must be considered, it would indeed be more convenient to have the two variables separated on the co-ordinates. However, on account of the drawbacks of the $1/(Y)$ versus $1/(XY)$ plot discussed above, it would seem preferable in these cases also to apply the noninverted plot and to use the lines through the origin to separate the variables for the purpose of weighting of data.

B. H. J. HOFSTEE
Palo Alto Medical Research Foundation, Palo Alto, California

References and Notes

1. J. B. S. Haldane, *Nature* **179**, 832 (1957).
2. H. Lineweaver and D. Burk, *J. Am. Chem. Soc.* **56**, 658 (1934).
3. G. Scatchard, *Ann. N.Y. Acad. Sci.* **51**, 669 (1949).
4. B. H. J. Hofstee, *Science* **116**, 329 (1952).
5. ———, *Nature* **184**, 1296 (1959).
6. ———, *J. Biol. Chem.* **199**, 357 (1952).

PHOTO BY WILL CONNELL

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Gea, Daughter of Chaos

Geology is the study of the earth, *selenology* the study of the moon. But what shall we call the study of Mars, of Venus, of one of the moons of Jupiter? Geocentric purists would restrict *geology,* and all the other terms that begin with *geo,* to the earth, and require the coinage of a new glossary for each other planet and moon. Before we really escape the earth's atmosphere, let us consider the terms we may best use to discuss the origin of planets and moons, their histories, and the processes that molded their surfaces.

We already have 60 or 70 accepted terms beginning with *geo,* not counting variant endings: geology, geomorphology, geophysics, geochemistry, etc. It is easy to construct a parallel list for another body, say Jupiter's moon Ganymede: ganymedology, ganymedomorphology, ganymedophysics, ganymedochemistry, etc. (Where, incidentally, would we switch from one list to the other? At what point in space would a geophone become a ganymedophone?) But our work is just begun. Multiplying the *geo* glossary to describe eight other planets and their 30 moons would require some 2500 new terms, and we haven't even mentioned the asteroids or left our own solar system. Truly the vocabulary could become astronomical.

We *could* coin a new glossary for each planet and moon, but let us reject this solution. It can appeal only to one who loves neology more than geology.

Geology and the *geo* terms can be extended from their earthly meaning to cover similar processes and features of other cosmic bodies. And the extension seems reasonable, for the most profound aspect of natural phenomena is their dependence upon generally operative processes.

Wherever they occur, a caldera is a caldera, sulfur is sulfur, and a reverse fault is a reverse fault. True, gravity, the atmosphere, and other local conditions will vary from one cosmic body to another, and these variations will influence the manifestation of underlying processes. But as these differences become known, they can be described; and surely our understanding of both the differences and the underlying similarities would be blighted by an indexing system that required expansion after expansion as we become acquainted with more and more of our cosmic neighbors. The vocabulary should be a help, not a confounding nuisance.

Extending geology to other bodies is not really likely to lead to confusion, for research on extraterrestrial bodies will have to be conducted on or near specific surface areas, and these areas will have to be named. No one can now write a technical paper on "The geology of the earth"; he must at least limit it to something like "The geology of the so-and-so Quadrangle, California, U.S.A." Would not the title "The geology of the so-and-so Quadrangle, Red Blazes, Mars" be clearer than "The marsology of the . . ."? A definitive, worthwhile study will be on a particular area, and the title will specify the area, be it terrestrial or extraterrestrial. Only one new rule is necessary: agreement that *geo* terms be followed by *of* when they are applied to moons or other planets. If this is done, "The geology of Venus" will be as clear and understandable as "The geology of Patagonia."

Perhaps it is well to remember that the word *geologia* was first used, in 1473 by the Bishop of Durham, to distinguish lawyers, who study earthly things, from theologians. The word has already changed meaning; it is not sacrosanct. If, instead of recognizing a simple mutation, we coin a new glossary for each new body, it will be fitting indeed that in Greek mythology Gea, the goddess of earth, was the daughter of Chaos.—JACK GREEN, *Aero-Space Laboratories, North American Aviation, Inc., Downey, California;* DAEL WOLFLE, *AAAS.*

11–13. American Assoc. for Thoracic Surgery, 40th annual, Miami Beach, Fla. (H. T. Langston, 7730 Carondelet Ave., St. Louis 5, Mo.)

11–13. American Inst. of Chemists, Minneapolis, Minn. (L. Van Doren, AIC, 60 E. 42 St., New York 17)

11–13. International Acetylene Assoc., annual, Seattle, Wash. (IAA, 30 W. 42 St., New York 17)

11–13. Quinones in Electron Transport, symp. (by invitation only), London, England. (G. E. W. Wolstenholme, Ciba Foundation, 41 Portland Pl., London, W.1)

11–13. Rare Earths in Biochemical and Medical Research, conf., Ames, Iowa. (J. G. Graca, College of Veterinary Medicine, Iowa State Univ., Ames)

11–14. American Helicopter Soc., annual, Miami Beach, Fla. (H. M. Lounsbury, AHS, 2 E. 64 St., New York 21)

11–14. National Science Fair-International, Indianapolis, Ind. (Science Service, 1719 N St., Washington 6)

12. Protein and Amino Acid Supplementation, Chicago, Ill. [J. T. Sime (Assoc. of Vitamin Chemists), Evaporated Milk Assoc., 228 North La Salle St., Chicago 1]

12–14. American Assoc. for Cleft Palate Rehabilitation, Denver, Colo. (D. C. Spriestersbach, University Hospitals, Iowa City, Iowa)

12–14. American Inst. of Industrial Engineers, annual, Dallas, Tex. (F. J. Titler, AIIE, 145 N. High St., Columbus 15, Ohio)

12–14. Virginia Acad. of Science, Richmond. (P. M. Patterson, Hollins College, Va.)

13–14. Proctological Latina, 2nd intern., Rome, Italy. (G. B. E. Simonetti, Via S. Raffaele 3, Milano, Italy)

15–18. American Soc. of Maxillofacial Surgeons, Los Angeles, Calif. (E. C. Hinds, 1508 Medical Towers, Houston 25, Tex.)

15–18. International College of Surgeons, 12th biennial conf., Rome, Italy. (ICS, 1516 Lake Shore Drive, Chicago, Ill.)

15–20. American Water Works Assoc., annual conv., Miami Beach, Fla. (H. E. Jordan, AWWA, 2 Park Ave., New York 16)

15–19. Institute of Food Technologists, 20th annual, San Francisco, Calif. (C. S. Lawrence, IFT, 176 W. Adams St., Chicago 3)

15–20. National Tuberculosis Assoc., Los Angeles, Calif. (J. C. Stone, 1790 Broadway, New York 19)

16–17. Society of American Military Engineers, natl. conv., Washington, D.C. (D. A. Sullivan, SAME, 140 S. Dearborn St., Chicago, Ill.)

16–18. American Ophthalmological Soc., Colorado Springs, Colo. (M. C. Wheeler, 30 W. 59 St., New York 19)

16–18. American Trudeau Soc., Los Angeles, Calif. (F. W. Webster, 1790 Broadway, New York 19)

16–19. American Urological Assoc., Chicago, Ill. (W. P. Didusch, 1120 N. Charles St., Baltimore 1, Md.)

16–20. Medical Library Assoc., Kansas City, Mo. (Miss N. A. Mehne, Upjohn Co. Library, 301 Henrietta St., Kalamazoo, Mich.)

16–21. American Assoc. on Mental Deficiency, annual, Baltimore, Md. (N. A. Dayton, P.O Box 51, Mansfield Depot, Conn.)

17–18. Superconductive Technique for Computing Systems, symp., Washington, D.C. (Miss J. Leno, Code 430A, Office of Naval Research, Washington 25)

17–20. American Assoc. of Plastic Surgeons, Milwaukee, Wis. (T. D. Cronin, 6615 Travis St., Houston 25, Tex.)

18–19. Agricultural Meteorology, 3rd conf., Kansas City, Mo. (K. C. Spengler, American Meteorological Soc., 45 Beacon St., Boston, Mass.)

18–20. Society for Experimental Stress Analysis, spring, Indianapolis, Ind. (W. M. Murray, SESA, P.O. Box 168, Central Square Station, Cambridge 39, Mass.)

18–27. Wool Conf., intern., Harrogate, Yorkshire, England. (A. W. Bennett, Textile Inst., 10 Blackfriars St., Manchester 3, England)

21–22. Society for Economic Botany, 1st annual, Lafayette, Ind. (Q. Jones, New Crops Research Branch, Beltsville, Md.)

22. Maryland Acad. of Sciences, Baltimore. (J. W. Easter, Owings Mills, Md.)

22–26. Air Pollution Control Assoc., 53rd annual, Cincinnati, Ohio. (C. W. Gruber, 2400 Beekman St., Cincinnati 14)

22–26. Oil and Gas Power Conf., Kansas City, Mo. (D. B. MacDougall, ASME, 29 W. 39 St., New York 18)

23–25. American Soc. for Quality

Control, annual conv., San Francisco, Calif. (W. P. Youngclaus, Jr., ASQC, 161 W. Wisconsin Ave., Milwaukee 3, Wis.)

23–25. National Telemetering Conf., Santa Monica, Calif. (A. F. Denham, American Rocket Soc., 925 Book Bldg., Detroit 26, Mich.)

23–25. Technical Assoc. of the Paper and Pulp Industry, Chicago, Ill. (J. Winchester, TAPPI, 155 E. 44 St., New York 17)

23–26. Design Engineering Conf., New York, N.Y. (D. B. MacDougall, ASME, 29 W. 39 St., New York 18)

23–28. American College of Cardiology, 9th annual conv., Indianapolis, Ind. (G. F. Greco, ACC, 114-08 Linden Blvd., Ozone Park 16, N.Y.)

23–28. Instruments, Electronics, and Automation Exhibition, Olympia, London, England. (Industrial Exhibitions Ltd., 9 Argyll St., London, W.1, England)

23–28. International Ceramic Cong., 7th, Great Britain. (G. N. Hodson, Organizing Council, c/o Hathernware Ltd., Loughborough, England)

23–28. International War—Prophylaxis Cong. for Physicians, Noordwijk ann Zee, Netherlands. (M. Knap, 46 Schubertstraat, Amsterdam, Netherlands)

25–26. Refractory Metals and Alloys, symp., Detroit, Mich. (E. O. Kirkendall, AIIE, 29 W. 39 St., New York 18)

25–5. International Federation for Housing and Town Planning, cong., Puerto Rico. (IFHTP, Park Hotel, Molenstraat 53, The Hague, Netherlands)

26–27. Psychophysiological Aspects of Space Flight (School of Aviation Medicine, USAF Aerospace Medical Center), symp., San Antonio, Tex. (J. Harmon, Southwest Research Inst., 8500 Culebra Rd., San Antonio 6)

26–28. Society of Naval Architects and Marine Engineers, spring, Washington, D.C. (W. N. Landers, SNAME, 74 Trinity Pl., New York 6)

29–2. Chemical Inst. of Canada, 43rd annual conf., Montreal, Quebec, Canada. (CIC, 18 Rideau St., Ottawa, Ontario, Canada)

29–4. American Soc. for Horticultural Science, 8th annual of Caribbean Region, San Juan, Puerto Rico. (E. H. Cásseres, Londres 40, O.E.E., Mexico 6, D.F.)

29–5. International Commission on Irrigation and Drainage, 4th cong., Madrid, Spain. (D. Diaz-Ambrona, Comité Nacional Español, c/o Ministerio de Obras Públicas, Agustín de Bethencourt, 4, Madrid, Spain)

30–1. American Gynecological Soc., Williamsburg, Va. (A. A. Marchetti, Georgetown Univ. Hospital, Washington 7)

30–2. American Orthopaedic Assoc., Hot Springs, Va. (L. R. Straub, 535 E. 70 St., New York 21)

30–3. Asian-Pacific Cong. of Cardiology, 2nd, Melbourne, Australia. (A. E. Doyle, Alfred Hospital, Melbourne, S.1, Victoria, Australia)

30–3. Fibre Science, annual conf., London, England. (A. W. Bennett, Textile Inst., 10 Blackfriars St., Manchester 3, England)

30–4. Reactivity of Solids, 4th intern. symp., Amsterdam, Netherlands. (Ir. G. van Gijn, Secretary, 4th Intern. Symp. on the Reactivity of Solids, Technisch Hogeschool, Eindhoven, Netherlands)