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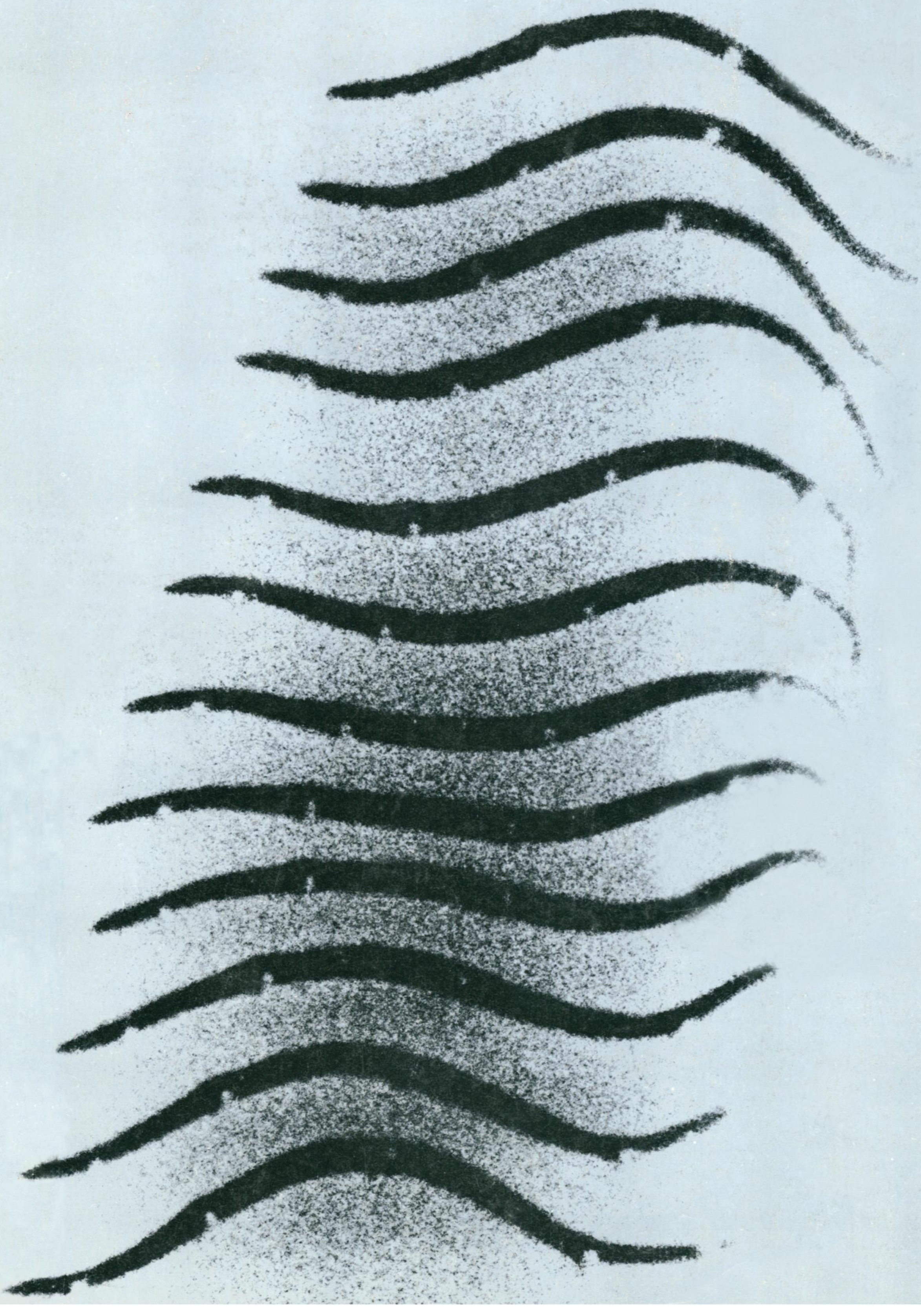

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SCIENCE

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COVER

Body wave of a swimming leech, as seen in sequence (top to bottom) of successive movie frames taken at 35-millisecond intervals. The right-to-left horizontal displacement depicts the true forward progress of the animal. See page 1348. [W. H. Kristan, Jr., C. A. Ort, and G. S. Stent, University of California, Berkeley]

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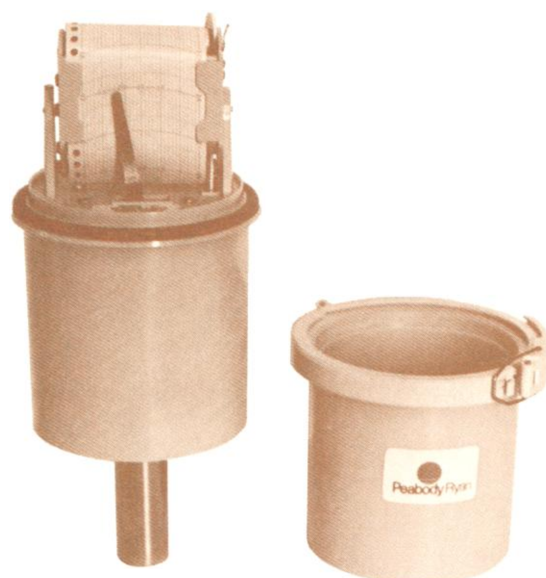

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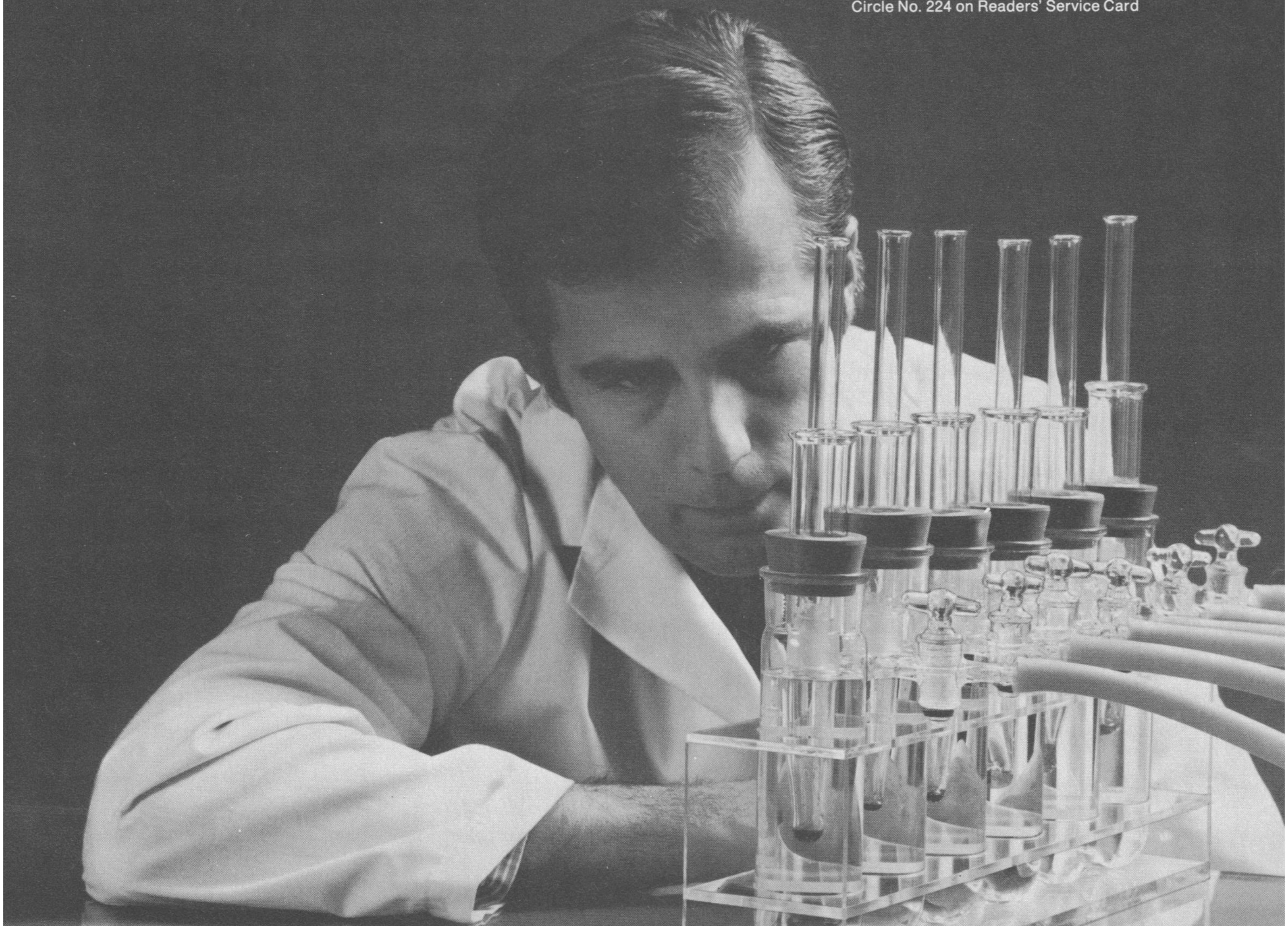

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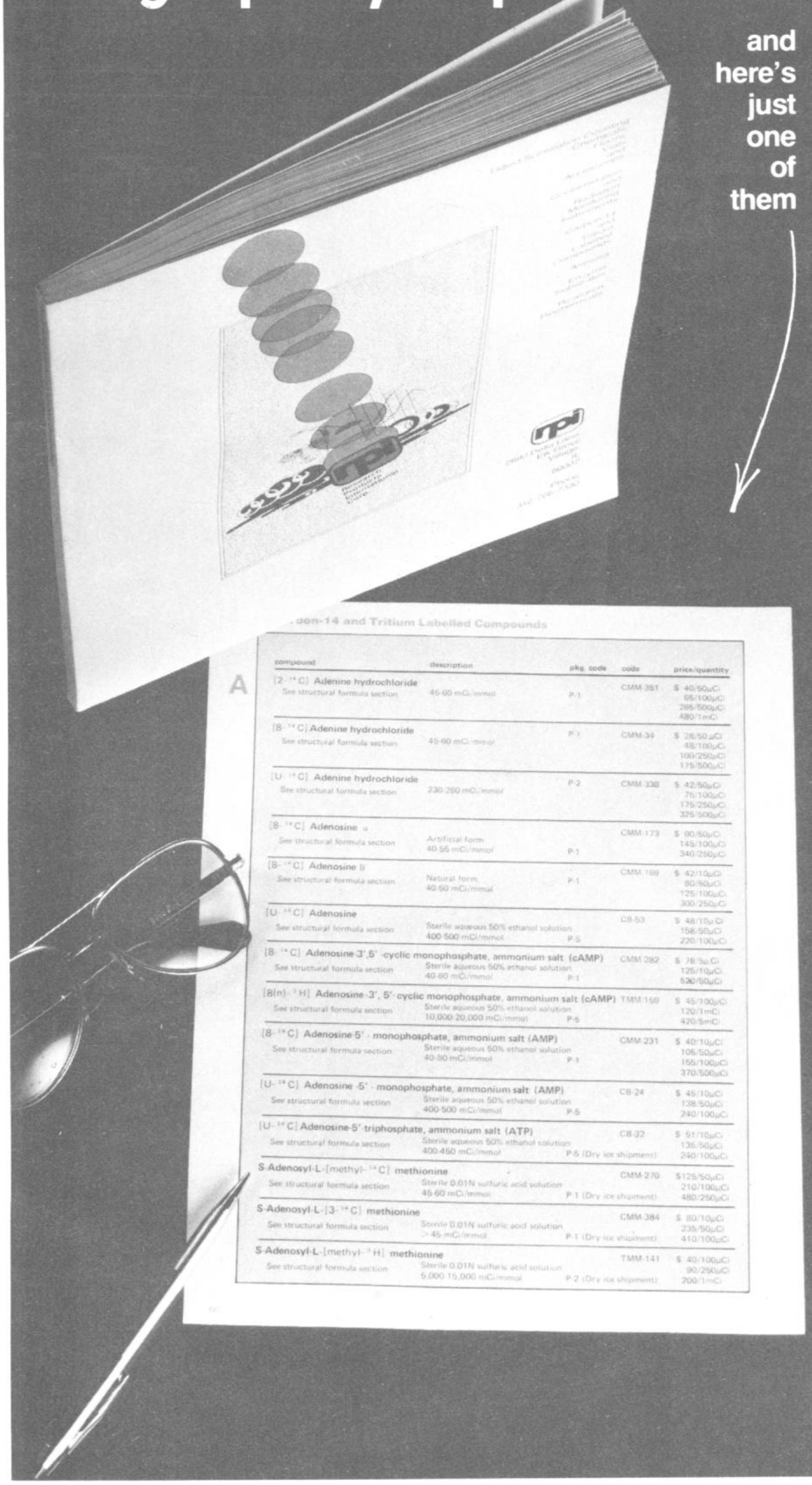

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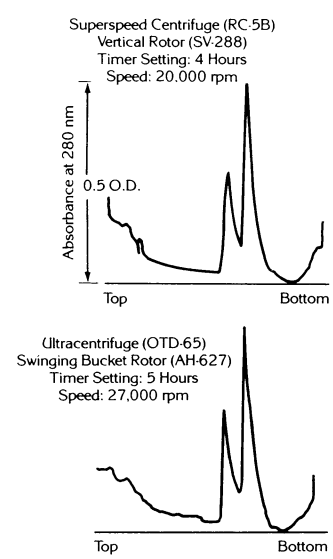

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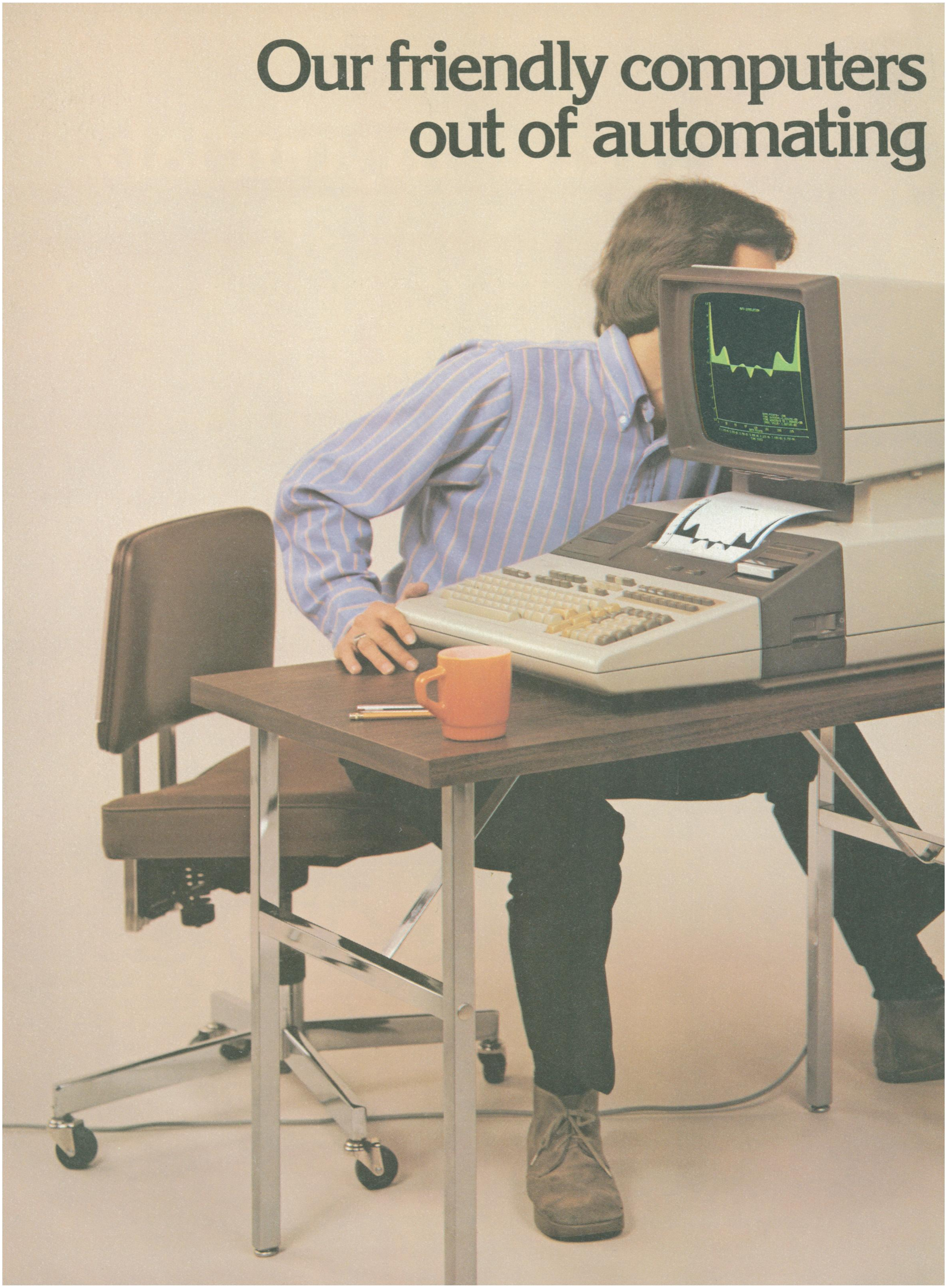

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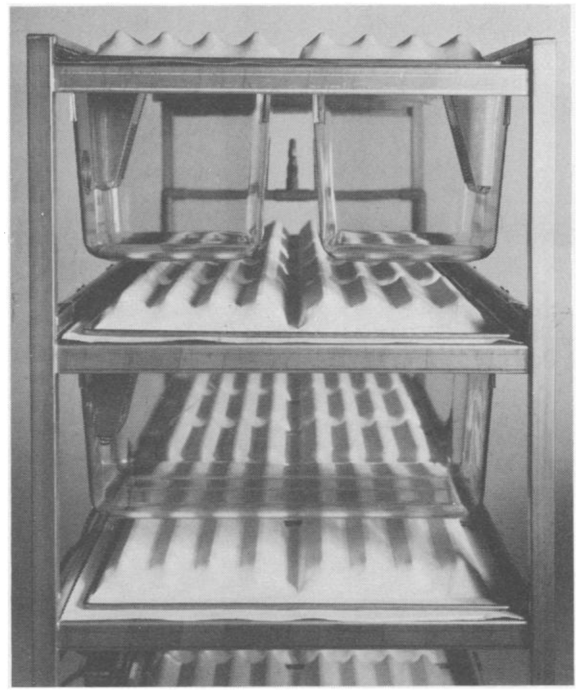

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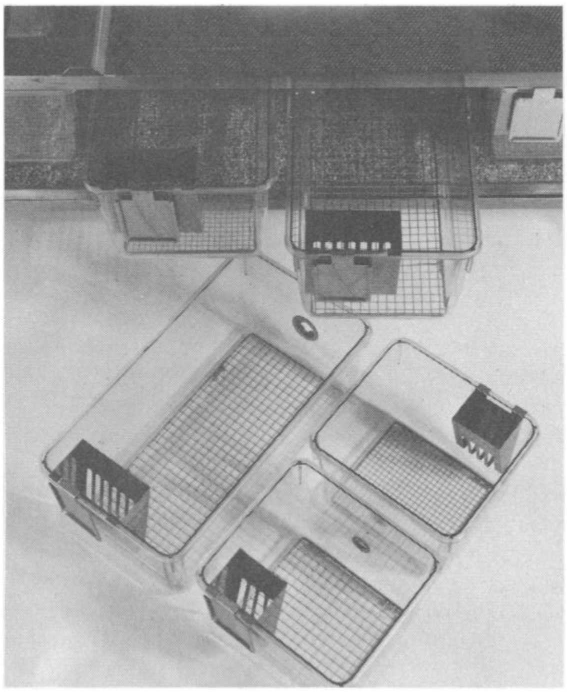

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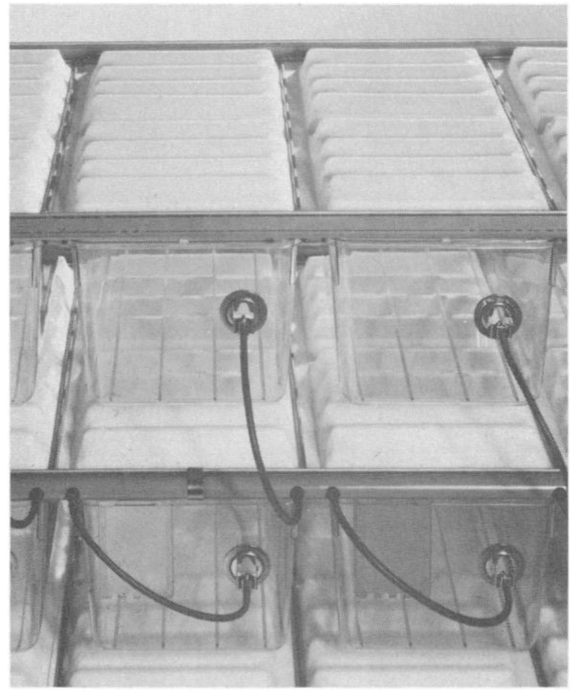

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R & D Expenditures in the United States

Recently published data (*1*) bear witness to the continuing erosion of support for science and technology in this country. The general trends of the data show two specific problems that deserve a high degree of attention by responsible authorities. These relate to (i) the total expenditure for research and development (R & D) in the nation as a whole and (ii) the expenditure for basic research in industry.

Although the debate regarding the appropriate level of R & D expenditure has continued over the years, with various factions advocating different economic indicators as a basis, no one has raised the issue that the level should perhaps depend upon equivalent activities in other developed nations with which we trade. Perhaps this is due to the continuing change in the value of U.S. currency with respect to that of other countries, as well as to the variation in direct and overhead costs per researcher, which makes such comparisons difficult.

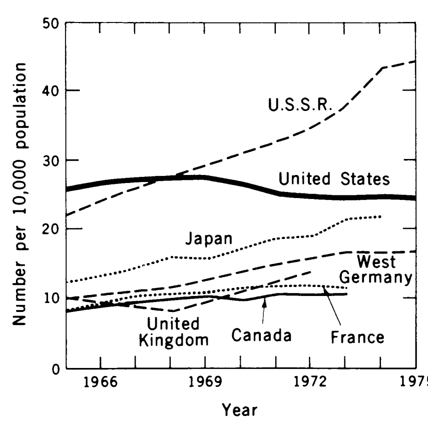


Fig. 1. Scientists and engineers engaged in R & D per 10,000 population by country, 1965–75.

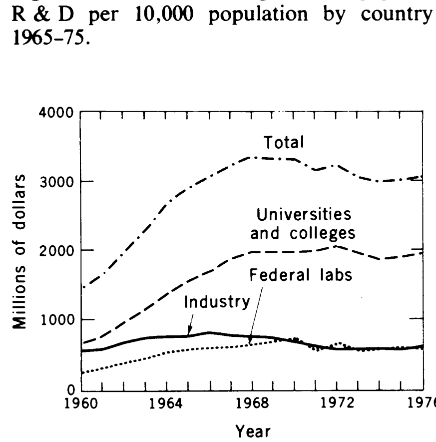
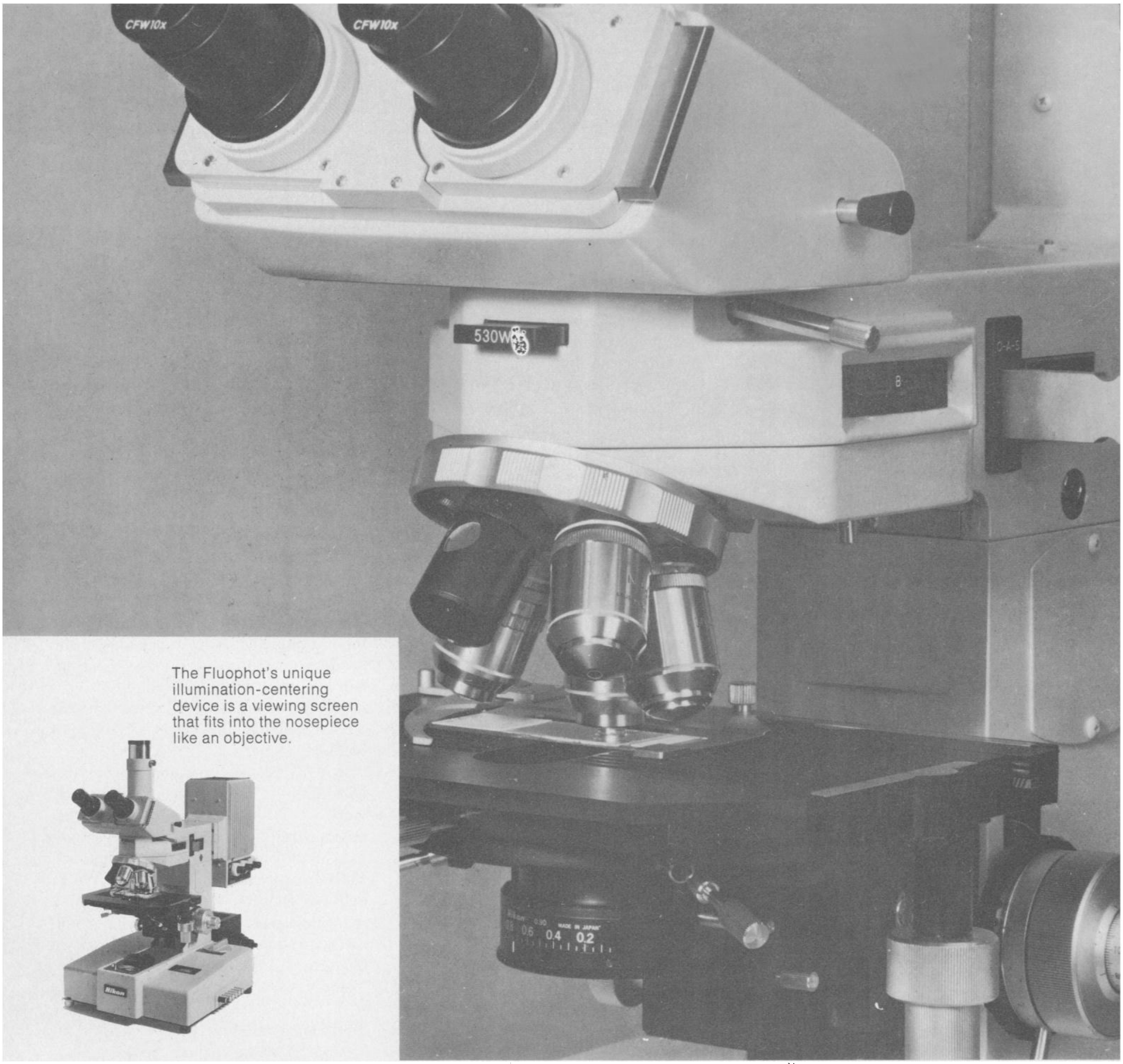


Fig. 2. Basic research expenditures by performer, 1960–76 (in constant 1972 dollars).

To overcome this confusion and to obtain a more meaningful comparison, I suggest we use the data on the total number of scientists and engineers engaged in R & D activities in the various countries (*1*, pp. 7 and 86). If we assume equivalent brainpower, dedication, and facilities, these data yield some interesting observations (Fig. 1). Perhaps the most striking comparison can be made between the United States and Japan, where the data show, respectively, 25 and 22 scientists and engineers per 10,000 of the general population for 1974. More recent data show the numbers to be 25 and 24, respectively, for 1975, with the number for Japan still rising. Since the population of Japan is about half that of the United States, it follows that, in absolute terms, the United States has twice as many people involved in R & D as does Japan, a preliminarily comforting thought.

Unfortunately, if we then look at the historical record of areas *where the government portion* of R & D expenditures has been used, we realize that, whereas the U.S. government spends approximately 64 percent of its R & D outlay on defense and space-related work, the Japanese government spends only 8 percent of its outlay (*1*, p. 9). These figures are approximate, but nevertheless they present a telling story about the magnitude of Japan's R & D effort. In terms of actual manpower in work not related to defense or space, Japan in 1975 had three scientists and engineers working in R & D for every four in the United States. While it is possible to cite a few past fallouts from space- and defense-related research in the United States, we should not overlook the fact that Japan has built a powerful R & D force aimed directly at commercial markets. The potential consequences of this strength in terms of overall economic returns for Japan, both now and in the immediate future, are apparent and need not be reemphasized.

The second problem relates to the level of basic research expenditures in industry. Here, the data (*1*, pp. 69 and 225) show a continuous drop since 1967 to the extent that, in 1976, the value of all basic research in industry, in constant dollars, remains approximately the same as that in 1960 (Fig. 2). The universities, fortunately, have fared much better, holding their level to approximately the same value as that in the 1967 peak year, or almost three times that in industry. The decline of basic research in industry has, unfortunately, come about through elimination of this type of work in many of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the small and medium-sized companies, where the absence of such skills now makes their interaction with universities more difficult. This may, therefore, exclude these companies from participation in joint university-industry research programs of the type that the National Science Foundation is attempting to promote (*2*). Although this trend is the direct result of judgments made by the managements of these industries (and perhaps reflects the view that more short-term than long-term investment is desirable at this time), the long-term impact of this change in policy is extremely detrimental to the country as a whole. The companies that will be able to participate in this program are those which need this assistance least, as they already have a reasonable internal component of basic research. Most of these companies will, in fact, shy away from the program because of its extra administrative burden. The result can be a generally unfavorable response to the program.

To counteract this unfortunate trend, it may be necessary for Congress to provide certain tax incentives to industry to promote basic research. With a basic research core reestablished in many of the companies that have now abandoned it, the hope for a more successful promotion of joint university-industry research programs through the National Science Foundation grants may come closer to reality.

MICHAEL M. SHAHIN
Webster Research Center, Xerox Corporation, Rochester, New York 14644

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1. National Science Board, *Science Indicators 1976* (National Science Foundation, Washington, D.C., 1977).
2. "Industry/university cooperative research activity" (Notice No. 72, Office of the Director, National Science Foundation, Washington, D.C., 29 March 1978).

Velikovskianism

One of Anthony F. Aveni's concluding statements in his review (20 Jan., p. 288) of *Scientists Confront Velikovsky* (*1*), a collection of papers from a 1974 AAAS symposium, is: "As far as Velikovskianism is concerned it is dead and buried. The final nail has been driven." Nothing could be further from the truth.

In its November 1977 issue, which appeared about the same time as *Scientists Confront Velikovsky*, *KRONOS*, an interdisciplinary journal devoted to the investigation of Velikovsky's theories, presented a very effective answer to the criticism in the book. That issue, which has been published as a book under the title *Velikovsky and Establishment Science* (KRONOS Press, Glassboro State College, Glassboro, N.J.; vi, 144 pp., illus., $9.95; also available in paperback version at $5), contains Velikovsky's AAAS address "My challenge to conventional views in science," rebuttals by Velikovsky to the arguments of four of his critics at the AAAS meeting, a special answer by Velikovsky to ten points raised by Carl Sagan, and rebuttals by six Velikovsky supporters to criticism contained in *Scientists Confront Velikovsky*. These articles show that the present-day critics of Velikovsky have not learned anything from the mistakes of those of the 1950 era, some of whom were shown not to have read the work they were criticizing.

I was not fortunate enough to attend the AAAS Velikovsky symposium. However, I did purchase the five cassette tapes prepared by the AAAS covering the morning and evening sessions of the symposium. After listening to them numerous times, including Velikovsky's rebuttals from the floor, I concluded that Velikovsky had the better of all arguments.

It is my personal opinion that anyone considering criticizing Velikovsky's work would do well first to read all his books carefully. Then he or she should read all the pro-Velikovsky writings such as those contained in *Pensée*, *KRONOS*, and *SIS Review*. I think it is probable that, having done so, a critic who is honest with himself or herself would be changed from anti-Velikovsky to pro-Velikovsky.

F. THOMAS LOWREY
2230 Clairmont Drive, Pittsburgh, Pennsylvania 15241

References

1. D. Goldsmith, Ed., *Scientists Confront Velikovsky* (Cornell Univ. Press, Ithaca, N.Y., 1977).

... In paragraph two of his review, Aveni misrepresents the time scale and disarranges the sequence of Velikovsky's cosmological scenario. According to *Worlds in Collision*, Venus was not ejected from Jupiter 2500 years ago as Aveni states; 2500 years ago would have been 166 years after the last cosmic catastrophe (−687) proposed by Velikovsky. . . .

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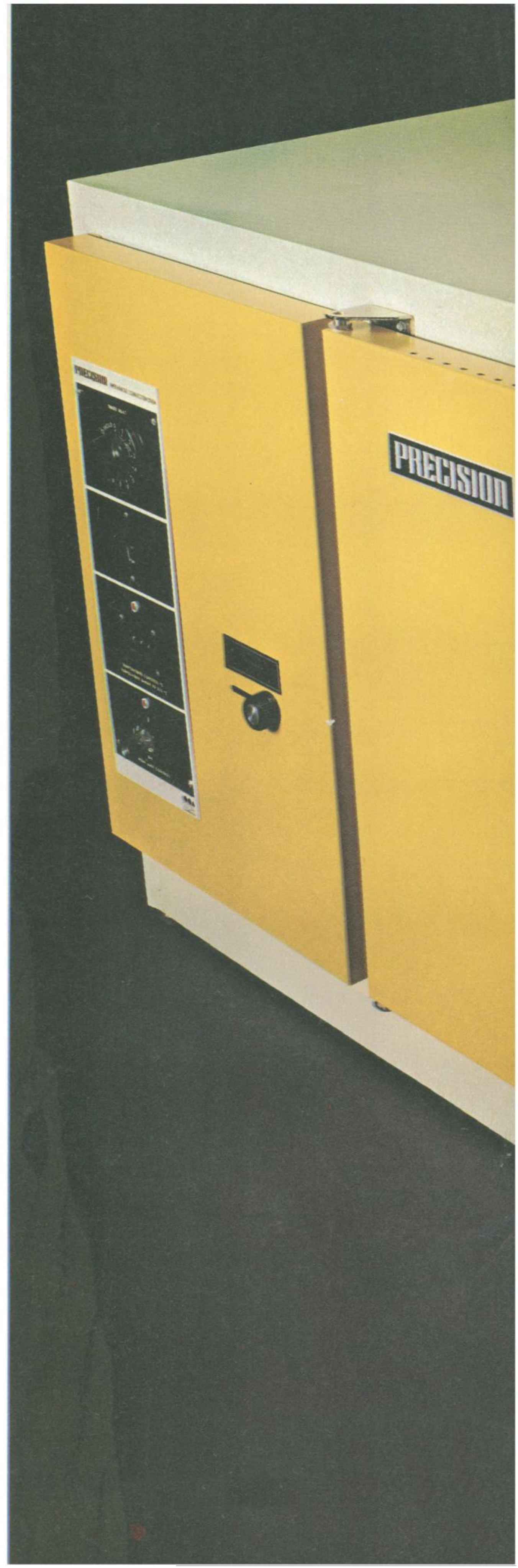

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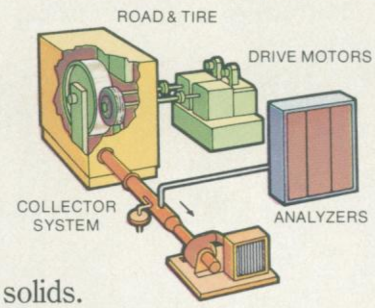
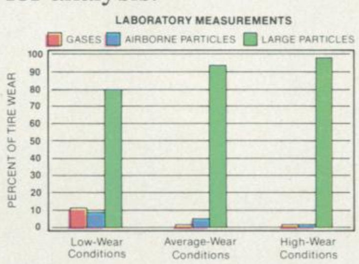


For this research, they had to design and build a special facility with an air-tight chamber. The facility allowed them to duplicate both front and rear tire wear under a wide range of driving conditions, and to collect all the wear products for analysis.



What did the study reveal? On the average, large (nonairborne) particles accounted for about 94% of total tread wear. Airborne particles, less than 5%. And gases, mostly hydrocarbon, a negligible 1%.

The particle results correlated with measurements of soil and air samplings taken along the San Gabriel River Freeway in Norwalk, California. (It was not feasible to measure gaseous hydrocarbons from tires at the road site.)

As for the disappearing act, outdoor measurements shed light on that too. The California study showed that the bulk of the tire debris lies within a five-meter strip next to the pavement edge.

All of which thus far suggests that tires play only a minor role in the air pollution picture.

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23 June 1978, Volume 200, Number 4348

SCIENCE

Scientists and World Needs

Scientists have a long tradition of international cooperation. Initially their interaction was based on admiration for scientific contributions. With time the intensity and scope of interaction have increased. Air travel and the telephone have multiplied the opportunities for meaningful contacts, mutual respect, and friendships. In consequence scientists have tended to be unusually internationally minded.

Until the last decade cooperation among scientists was focused strongly on fostering science. But now substantial emphasis is being directed toward important world problems. In seeking to be helpful in meeting human needs elsewhere, scientists have discovered that the practical problems are complex and difficult; quick solutions are enormously costly. The world's scientists possess a substantial fraction of relevant intellectual capacity; they have very little control of funds.

Under such circumstances, it would be easy to become frustrated. But this has not happened; rather the tempo of organized efforts has increased, stimulated in part by the forthcoming United Nations Conference on Science and Technology for Development. But activities by scientists will go on long after the meeting at Vienna in August 1979.

An important focus of the continuing efforts will be the International Scientific Unions. One example of activities involves the International Union of Pure and Applied Chemistry (IUPAC). Its activities are carried out by 1500 experts from 43 member countries who cover the spectrum of chemistry-related sciences and technologies. For most of its 59 years of existence the Union devoted its efforts to the regulation of atomic weights, chemical nomenclature and symbolization, analytical procedures, and standard methods of assay.

But IUPAC has recognized that though such activities are useful they are not enough, and it has created a mechanism designed to aid in identifying and solving problems of chemistry having direct impact on human needs. The effort bears the title Chemical Research Applied to World Needs (CHEMRAWN). IUPAC's initial enterprise under CHEMRAWN is a first World Conference on Future Sources of Organic Raw Materials. This major conference will discuss alternatives to petroleum as future sources of chemicals and chemical feedstocks. The conference, to be held in Toronto from 10 through 13 July 1978, will be attended by world leaders from government, industry, and academia. They will seek to define those factors that will determine the sources of organic raw materials at the end of this century.

Another example of effort by the scientific unions is an activity spearheaded by the umbrella organization for all of them—the International Council of Scientific Unions (ICSU). Through ICSU initiative, a number of nongovernmental organizations including those of engineers and social scientists will host a symposium in Singapore during late January 1979 that will involve participants from many countries. Objectives of the meeting include identification of substantive inputs into the U.N. Conference on Science and Technology for Development. Of more lasting consequence is exploration of institutional and other innovations which would enlarge the opportunities for scientists and engineers to participate in future years in the improvement of the human condition. One of the important objectives of the symposium is to illuminate the basic conditions necessary for the assimilation of science and technology into developing countries in a manner which significantly contributes to the development process. The symposium will explore such questions as "How can a systematic approach be made country by country to selection of technology relevant to it?" Such an approach is required because the various nations differ greatly in educational levels, technological know-how, internal markets, natural resources, financial strengths, managerial talents, and political climates.

Scientists cannot do everything, but if they select limited and doable objectives, they can make a meaningful difference.—PHILIP H. ABELSON

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PRODUCTS and MATERIALS

Research Microscope

The Optiphot is available with accessories for phase contrast, dual observation, incident-light fluorescence and darkfield, and Nomarski differential interference contrast (transmitted and reflected) microscopy. The CF objectives and eyepieces employ extra-low dispersion glass and integrated multilayer coatings and they are free of chromatic aberration across the entire field of view. The Siedentopf body tubes adjust to assure constant length and they are inclined 30 degrees from the horizontal for comfort. The nosepiece accommodates five objectives. The Koehler illumination system covers all magnification ranges without change. Nikon. Circle 707.

Liquid Chromatography Column

The Partisil-5 is a reversed-phase accessory for high-performance liquid chromatography. It is fully silanized; octadecylsilane (C_{18}) groups are bonded (Si-O-Si) to a silica gel matrix in which particles vary in size by ± 0.5 micrometer. The column is guaranteed efficient at 45,000 plates per meter. It is available in analytical form at 4.6 millimeters inside diameter by 250 millimeters long and may be equipped with any of several end fittings for use with any liquid chromatograph. Whatman. Circle 708.

Cytometry System

The Cytofluorograf System 50 offers analysis and sorting of cells. It contains two lasers, four detectors, and 12 distinct modes of measurement. There are two bidimensional regions for selection of subpopulations for sorting, differential counting, and frequency distribution. The helium-neon laser measures scatter and an argon laser measures fluorescence. The detectors measure pulse height, pulse area, and pulse width. Correlation of these measurements yields morphologic information from the output of the four detectors. Ortho Instruments. Circle 709.

Fraction Collector

The Fractomette Alpha 200 offers push-button selection of modes of collection including time, drop, or volume. Options include stainless steel trays, electrolyte bulb, connecting leads, and mounting hardware. The compact design accommodates up to 200 tubes per rack and the design permits easy removal and replacement of entire racks. The collector is operated by a single motor and the entire device is compact enough to be operated in a commercial refrigerator if desired. Buchler Instruments. Circle 710.

Laboratory Work Stations

The Hydrovoid atmosphere control system provides a dry or special inert atmosphere and the Microvoid dust hood removes airborne contaminants. The systems are modular and may be connected in series to control the atmosphere at specific sites in the laboratory. Systems may be designed to include clean chambers, storage cabinets, and accessories such as filters, dry box gloves and sleeves, and entry and scope ports. Air Control. Circle 711.

Serum Iron Analyzer

The FerroChem model 3050 measures iron in serum and total iron-binding capacity. Results for each determination are displayed in 60 seconds. In the analysis of total iron-binding capacity, a 50- to 100-microliter sample requires a 5-minute ion-exchange process for measurement. Serum iron determination requires only 10 to 100 microliters of serum. Calibration is simple with an inorganic iron standard or commercially available reference sera and a blank control. Preparative chemistry is minimized or eliminated and the electrochemical method employed is very sensitive and precise. Environmental Sciences Associates. Circle 712.

Tissue Sectioner

The Vibratome will section most fresh animal or plant tissue without freezing or embedding. A vibrating blade distributes cutting force evenly laterally. The operator controls blade vibration, feed rate, the specimen vise, cutting angle, and thickness of section. The device will slice as thin as 10 micrometers. The blade angle is adjustable from 1 to 50 degrees. A fluid bath lubricates the blade, prevents build up of heat, and allows easy retrieval of cut sections. Blades are disposable and easy to change. Operator selects the type of fluid for the bath. Oxford Laboratories. Circle 713.

Literature

Water-Testing Reagents are listed for all tests specified in sections 300 and 400 of the latest APHA *Standard Methods* handbook. Hellige. Circle 714.

Thin Layer Chromatography describes plates with a spotting guide and metric Rf scale to eliminate overlays and templates. Analtech. Circle 715.

High Performance Liquid Chromatograph is devoted to the series 2000 modular unit for analysis and certain preparative applications. Instrumentation Specialties (ISCO). Circle 716.

Scientific Glassware catalogs a complete line of apparatus and includes graph paper on which a researcher might describe a piece to be custom made for any special application. Lab Crest Scientific Glass. Circle 717.

Column Air Bath Oven features the LC-100 module for any liquid chromatograph. Perkin-Elmer. Circle 718.

Spectrophotometer describes the model 380 for research measurement of linear absorbance, concentration or transmittance. Turner Associates. Circle 719.

Water-Testing Apparatus includes the black BOD bottle and a new grab sampler for collecting effluent samples. Wheaton Scientific. Circle 720.

Newly offered instrumentation, apparatus, and laboratory materials of interest to researchers in all disciplines in academic, industrial, and government organizations are featured in this space. Emphasis is given to purpose, chief characteristics, and availability of products and materials. Endorsement by *Science* or AAAS is not implied. Additional information may be obtained from the manufacturers or suppliers named by circling the appropriate number on the Readers' Service Card (on pages 1326A and 1422G) and placing it in the mailbox. Postage is free.
—RICHARD G. SOMMER

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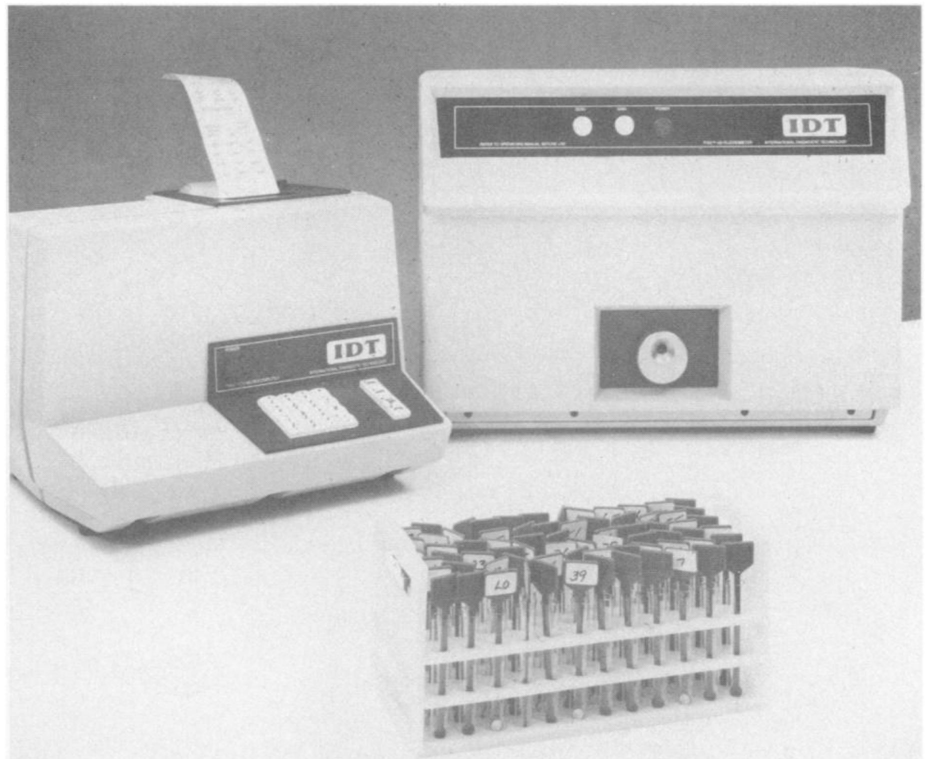

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R. Hart, A. Krezlewicz and D. Madden, "Use of a New Fluorescent Immunoassay System for Detection of Cytomegalovirus and Herpes Antibodies" (Paper delivered at the AAI Meeting, Atlanta, GA, June 1978).

D. D'Arcangelis and R. Deibel, "Experience with a Quantitative Assay of Rubella Antibody by a Single-Serum-Dilution Indirect Immunofluorescence (IF) Test" (Paper delivered at the ASM Meeting, Las Vegas, NV, May 1978).

P. Stiffler and L. Yang, "Comparison of FIAX™ system with Immunofluorescent Antibody (IFA) Technique for Detection of Anti-Nuclear Antibodies in Human Serum" (Paper delivered at the ASM Meeting, Las Vegas, NV, May 1978).

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BOOKS RECEIVED

(Continued from page 1378)

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Doing Psychology Experiments. David W. Martin. Brooks/Cole, Monterey, Calif., 1977. x, 198 pp., illus. Paper, $6.95.

Drug Disposition during Development. Paolo Lucio Morselli, Ed. Spectrum, New York, 1977 (distributor, Halsted [Wiley], New York). xviii, 490 pp., illus. $40. Monographs in Pharmacology and Physiology, vol. 2.

Electronic Devices and Circuit Theory. Robert Boylestad and Louis Nashelsky. Prentice-Hall, Englewood Cliffs, N.J., ed. 2, 1978. xviii, 702 pp., illus. $17.95.

Energy and the Atmosphere. A Physical-Chemical Approach. Ian M. Campbell. Wiley, New York, 1977. x, 398 pp., illus. Cloth, $35.95; paper, $14.50.

Estrangement, Alienation and Exploitation. A Sociological Approach to Historical Materialism. John Torrance. Columbia University Press, New York, 1977. xvi, 374 pp. $22.50.

Ethnic Medicine in the Southwest. Edward H. Spicer, Ed. University of Arizona Press, Tucson, 1977. viii, 292 pp. Cloth, $16.50; paper, $6.95.

Experimental Approach to Electrochemistry. N. J. Selley. Halsted (Wiley), New York, 1977. viii, 212 pp., illus. $19.75.

Final Environmental Impact Statement on NIH Guidelines for Research Involving Recombinant DNA Molecules. National Institutes of Health, Bethesda, Md., 1977 (available from the Superintendent of Documents, Washington, D.C.). Two parts. x, 138 pp. + appendixes. Paper, $9.75.

Functional Electrical Stimulation. Applications in Neural Prostheses. Papers from a workshop, Pomona, Calif., May 1976. F. Terry Hambrecht and James B. Reswick, Eds. Dekker, New York, 1977. xviii, 544 pp., illus. $45. Biomedical Engineering and Instrumentation Series, vol. 3.

The Game of Science. Garvin McCain and Erwin M. Segal. Brooks/Cole, Monterey, Calif., ed. 3, 1977. viii, 184 pp., illus. Paper, $4.95.

Geothermal World Directory. 1977/78 Edition. Geothermal World Publications, Reseda, Calif., 1977. 384 pp. $40.

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Inferential Statistics for Geographers. G. B. Norcliffe. Halsted (Wiley), New York, 1977. 272 pp., illus. $19.50.

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Legal and Scientific Uncertainties of Weather Modification. Proceedings of a symposium, Durham, N.C., Mar. 1976. William A. Thomas, Ed. Duke University Press, Durham, N.C., 1977. viii, 156 pp. $9.75.

The Life of William Carmichael M'Intosh,

M.D., F.R.S., of St. Andrews, 1838–1931. A Pioneer in Marine Biology. A. E. Gunther. Published for University of St. Andrews by Scottish Academic Press, Edinburgh, 1977. 214 pp. + plates. Paper, £5.

Living New World Monkeys (Platyrrhini) with an Introduction to Primates. Vol. 1. Philip Hershkovitz. University of Chicago Press, Chicago, 1977. xiv, 1118 pp., illus. + plates. $80.

Locational Analysis in Human Geography. Peter Haggett, Andrew D. Cliff, and Allan Frey. Halsted (Wiley), New York, ed. 2, 1977. xiv, 606 pp., illus. Cloth, $45; paper (in two volumes), $10.75 and $16.75.

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Our Restless Earth. The Geologic Regions of Tennessee. Edward T. Luther. University of Tennessee Press, Knoxville, 1977. xii, 94 pp., illus. Paper, $3.50. Tennessee Three Star Books.

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Platelets and Thrombosis. D. C. B. Mills and F. I. Pareti, Eds. Academic Press, New York, 1977. vi, 190 pp., illus. $13.25. Proceedings of the Serono Symposia, vol. 10.

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