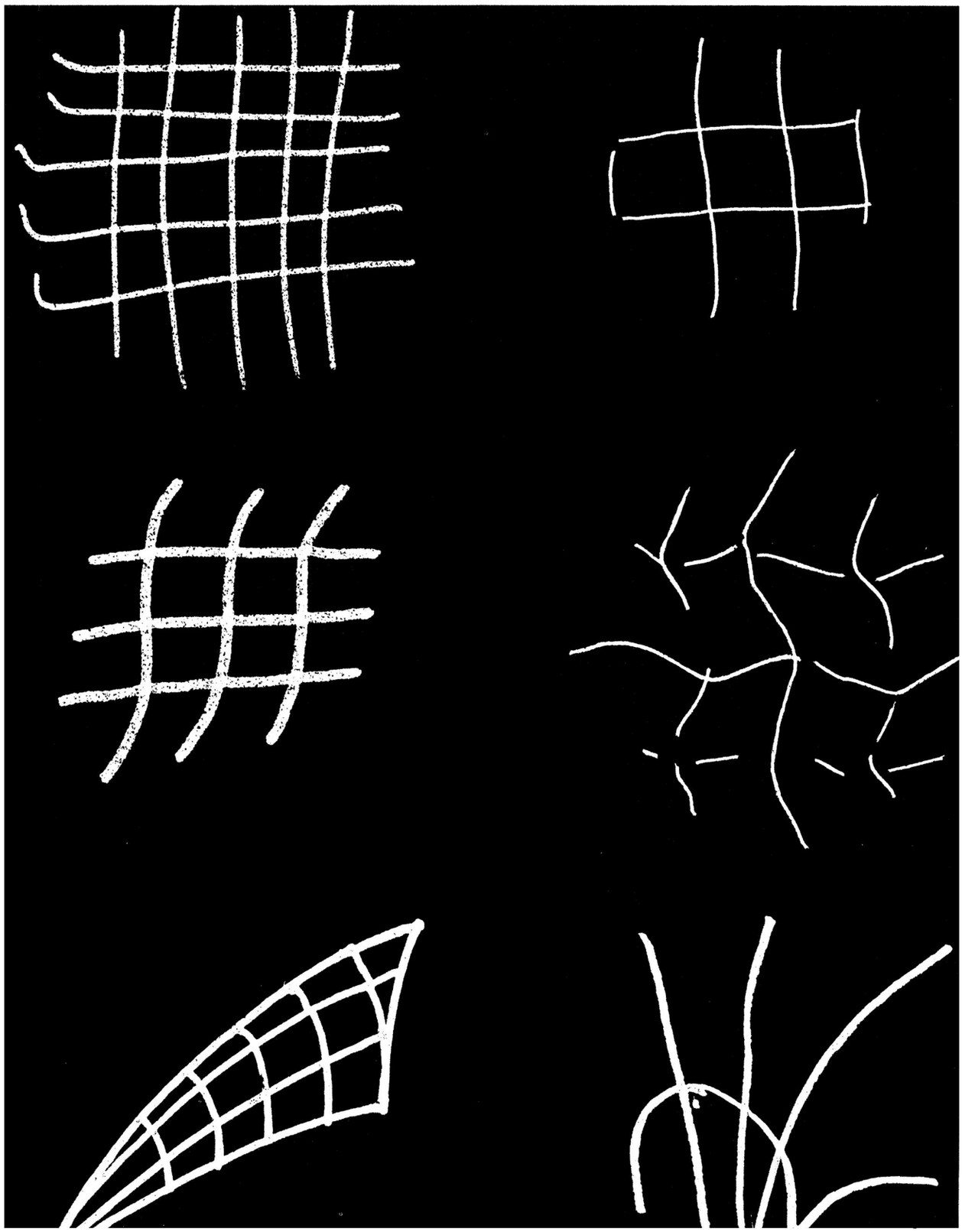
SCIENCE

13 August 1976

Volume 193, No. 4253

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



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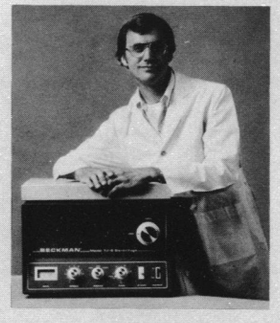

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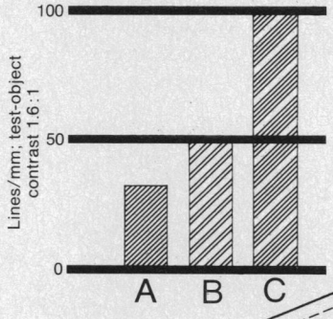

A comparison of the resolving power of three color transparency films. A is KODAK High Speed EKTACHROME Film; B is KODACHROME 25 Film; C is KODAK 2483 Film.

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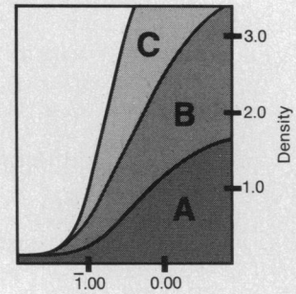

Characteristic curves for SO-410 Film. With appropriate development, the Contrast Index can be varied from 0.8 (curve A) to 3.4 (curve C), or values in between, such as 1.7 (curve B).

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If you need more information on the many aspects of photomicrography, we refer you to the new edition of *Photography Through the Microscope*, our Publication P-2.

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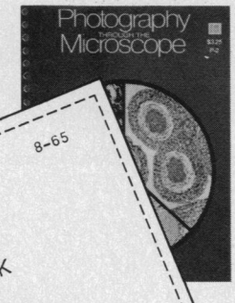

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13 August 1976

Volume 193, No. 4253

SCIENCE

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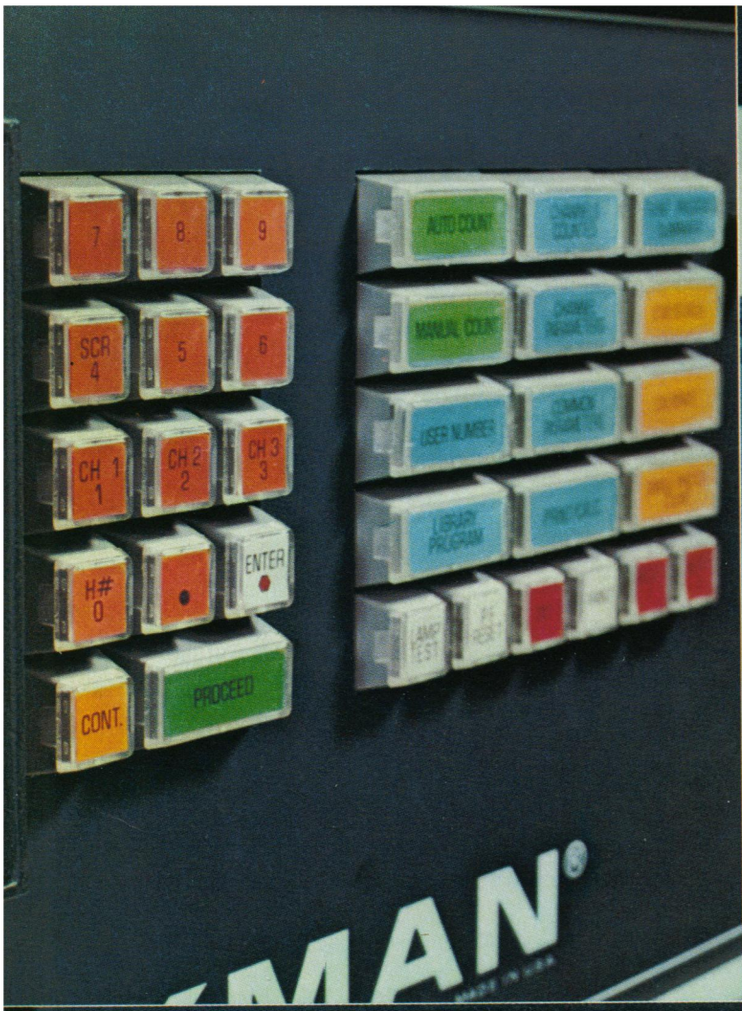
COVER

Waveform distortion patterns for six subjects with (top row) both 20/13 visual acuity, (middle row) 20/20 and 20/25, and (bottom row) 20/50 and 20/800 (conical cornea) visual acuity. Diagram of top right and that immediately below it are for same eye with and without contact lenses. See page 580. [Bradford Howland and Howard C. Howland, Cornell University, Ithaca, New York]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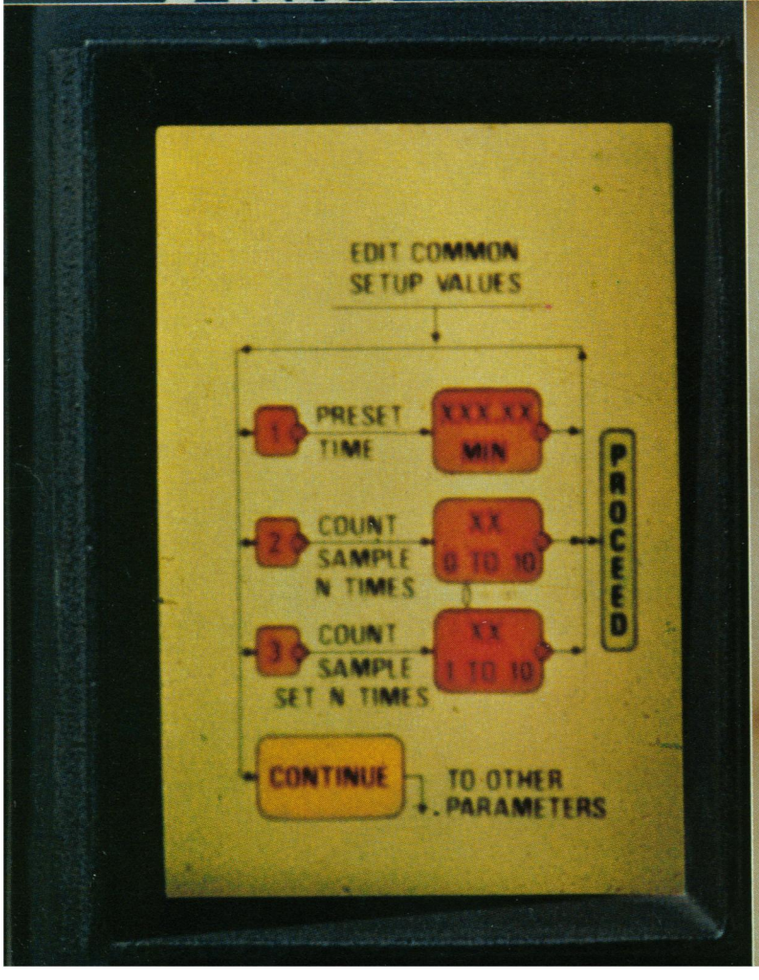
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LETTERS

Kepone: Hazard to Aquatic Organisms

Rudolph J. Jaeger (Letters, 9 July, p. 94) reports the chronology of mammalian toxicity tests with Kepone (chlordecone) and the exposures of workers at the Life Science Products Company of Hopewell, Virginia. Initial concern has properly been focused on the results of toxicity and carcinogenicity tests on rats, rabbits, dogs, and mice and on the disease that Kepone produced in exposed workers. We would like to document our concern about the hazard of Kepone to aquatic organisms in the James River and the Chesapeake Bay.

On-site tests of organisms taken from the James River showed significantly high Kepone concentrations. These tests, conducted at the Virginia Institute of Marine Science and funded by the Environmental Protection Agency (EPA), revealed that concentrations in edible tissues of most fresh and estuarine fin- and shellfish commonly ranged from 0.1 to more than 1 microgram per gram. These concentrations exceeded allowable health limits for commercial and sport fisheries and forced closure of the river to some commercial and sport fishing. This year Kepone concentrations have increased in anadromous fishes as they spent more time in the river.

Further, after laboratory exposures at the EPA laboratory in Gulf Breeze, Florida, we found that Kepone, like other chlorinated insecticides, is highly bioaccumulative and persists in estuarine organisms. Oysters, grass shrimp, and fishes have bioconcentrated Kepone from 425 to 20,000 times the concentration in the surrounding water. Therefore, action levels for edible seafoods now in force might be reached by as little as 5 parts of Kepone per trillion parts of water (nanograms per liter). In Kepone-free water, oysters can depurate about 90 percent of the accumulated Kepone in 4 days, but fish may require more than 3 weeks to lose 30 to 50 percent. Five weeks after fertilization of sheepshead minnow eggs containing Kepone, the juvenile fish retained as much as 46 percent of the Kepone present in the eggs. Kepone can be accumulated by fish to concentrations that exceed those in their food.

Kepone is acutely toxic to estuarine organisms, but long-term bioassays reveal that the hazard to these organisms is greatly underestimated by the 96-hour tests. The concentrations in micrograms per liter, estimated to be lethal to 50 percent of the test animals in 96 hours (LC_{50}), were 6.6 for spot, 70 for sheepshead minnows, 10 for an estuarine mysid, 121 for grass shrimp, and more than 210 for blue crabs. Kepone was lethal to adult sheepshead minnows exposed to 0.8 microgram per liter for 28 days. A significant number of embryos from adults exposed to 1.8 micrograms per liter were abnormal and died. When embryos were exposed to 0.08 microgram of Kepone per liter of water, 36 days later, resulting juvenile fish were shorter than control fish and some exhibited scoliosis. Mysid shrimp exposed for 20 days to about 0.2 microgram per liter produced fewer progeny; with greater concentrations, their growth and survival were reduced. We are concerned because all concentrations tested thus far in long-term exposures of sheepshead minnows and mysids have reduced survival, reproduction, or growth.

The threat of an even greater impact of Kepone to aquatic organisms in the James River and expansion of this impact into the Chesapeake Bay, therefore, is real and it may continue for some years to come. It is essential that we use knowledge now available to attempt to make decisions that may minimize the future impact of this insecticide on the aquatic environment.

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DELWAYNE R. NIMMO
STEVEN C. SCHIMMEL
LOWELL H. BAHNER
Environmental Protection Agency, Environmental Research Laboratory, Gulf Breeze, Florida 32561
ROBERT HUGGETT
Virginia Institute of Marine Science, Gloucester Point 23062

Structured Water or Pumps?

In her reporting of the ion-water controversy (Research News, 18 June, p. 1220), Gina Bari Kolata is to be commended for her attempt to achieve a balanced presentation of opposing views on a hot argument. All the same, rebuttals to some lines of evidence disputed by the ion "pump" enthusiasts were incorrectly represented, while other telling data, rarely considered, did not surface.

According to the *Science* article, critics claiming that pumps are still feasible despite the thermodynamic conflict, continue to cling to the argument that Minkoff and I have not accounted for the radioactive labeling of the cellular phosphate pool even though we have shown that labeling of this pool occurs instantaneously (*1*). That the "pool would limit the rate at which the labeled phosphate would be

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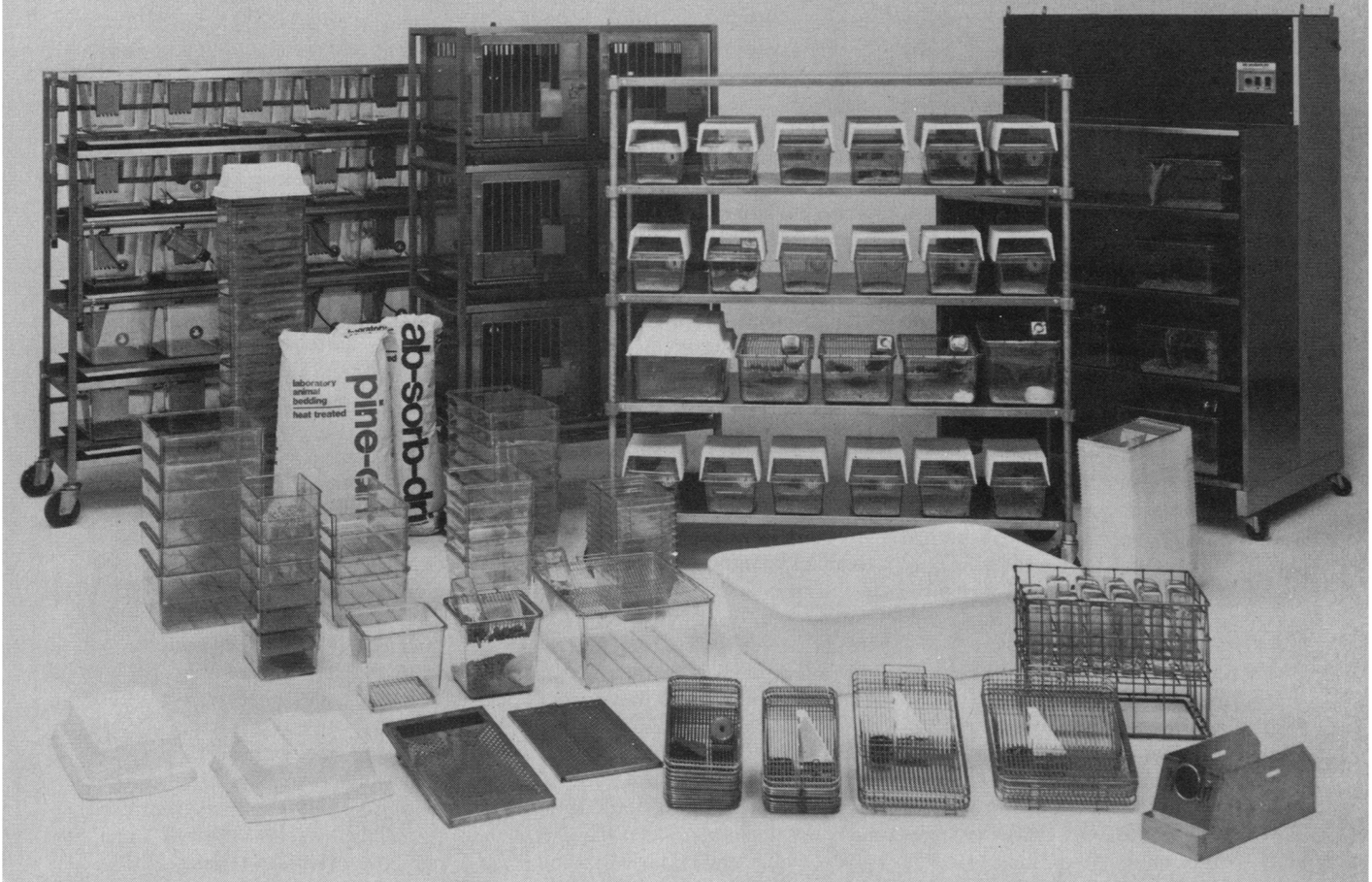

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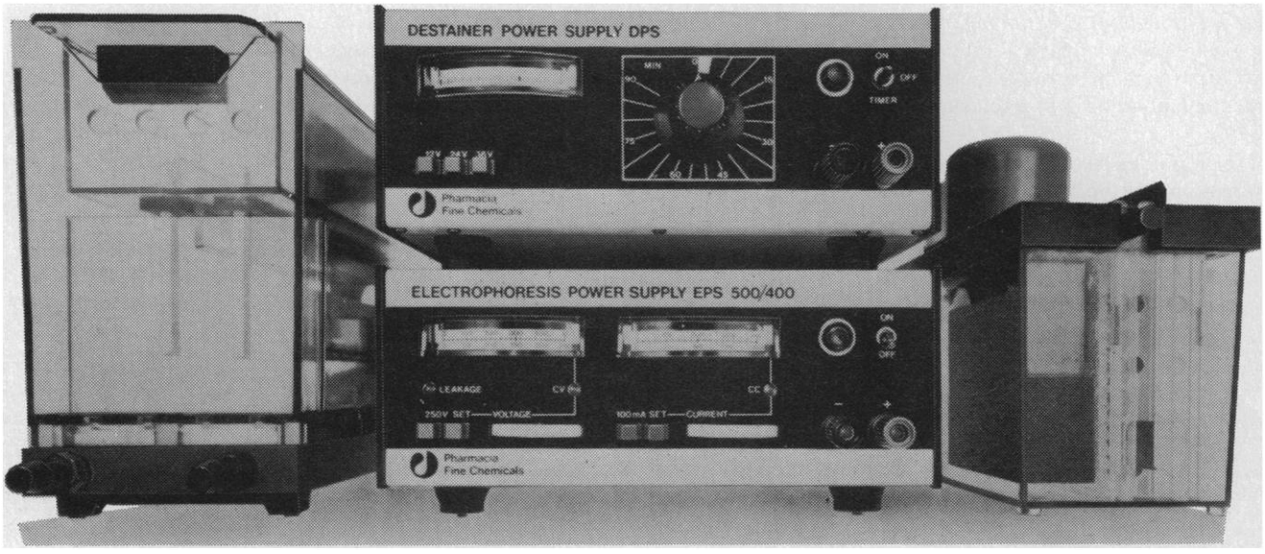

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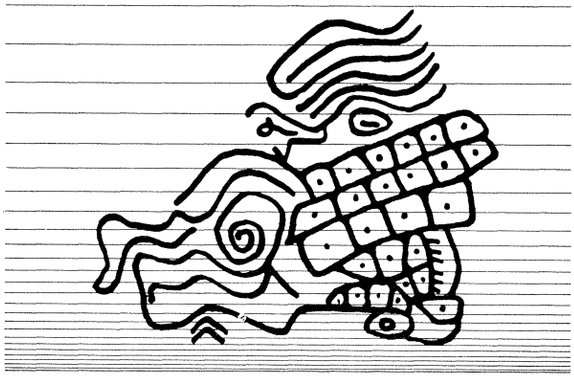

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13 August 1976, Volume 193, Number 4253 **SCIENCE**

Politics and Reason

A presidential campaign is a fine spectacle. If it is no more than that, for whatever reasons, it is time to ask why. When the republic was being arranged, the Federalist papers burrowed deeply into regions of political thought and meanings. Nearly two centuries later, the ordained rhythms of politics seem an end in themselves, concerned with a transition of parties and power but not a transition of reason or purpose. It is a troubling curtain raiser on our third century.

The function of elective politics is to choose leadership. This is a choice to be grounded on substance rather than on electronic and acoustic images. The characters and abilities of the potential leaders enter into making the choice, but it is the substance that defines the quality of the choice. What are the terms on which an affluent and technologically powerful nation proposes to conduct its affairs in a troubled world? For that matter, are affluence and power, together with the means to secure and preserve them, to be the continued goals of our public policies and the measure of effective leadership? If *not* affluence and power, then what? In the scramble for votes, who is going to speak of such matters, and who will listen?

It may be said fairly that this is a brimming century of information and knowledge. Science, technology, and humanism have all spread a feast of information before us for the taking. Our comprehension of the human condition and its dilemmas is not yet what it should be, but there is no denying that we know enough to grasp the dimensions of our responsibilities and the consequences of trifling with them. If the turmoil of the past decade has resulted only in giving issue politics a permanent bad name, we are in trouble. At the margins of one's memory there is an echo of Adlai Stevenson's advice to a Princeton senior class: to touch the truth and feel the hem of heaven.

For at least two decades, American science with good reason has argued for something resembling a national science policy framework. Some of the elements of such policy are now written into recent legislation. Even so, it seems more likely that the future directions of science and technology in the United States will be shaped by the working premises, values, and general mind-set of the country. If the accepted proposition were to be, for instance, the unconstrained economic growth is the consensus goal, then science and technology would be called upon to support it. If, instead, the common sense is that compulsive and unqualified growth will lead to new disorders and the exhaustion of both resources and human tolerance, then science and technology would have a very different agenda. How does knowledge get worked into so fundamental a choice as this?

It is a very large and real question. Rufus Miles, in a provocative book,* argues that we are close not only to the limits of growth but to the limits of political solutions. A hundred years ago Thomas Huxley saw what was coming and observed that "Size is not grandeur and territory does not make a nation. The great question is *what are you going to do with all this? What is to be the end of which this will be the means?*"

There is still time for a politics of reason. It has been in fashion to parade the costly failures of knowledge. Too little has been said of its indispensability. To pin the future simplistically to the idea that more is bound to be better, without recycling Huxley's questions, is to ignore the profound dilemmas in the relationship between power and responsibility. Nor is it enough to be content with assurances of the future health and exuberance of science and technology, apart from addressing their uses. This is what "science and public policy" ought to mean to us: a reach for higher ground in the partnership of knowledge with governance.—WILLIAM D. CAREY

*R. E. Miles, Jr., *Awakening from the American Dream* (Universe Books, New York, 1976).

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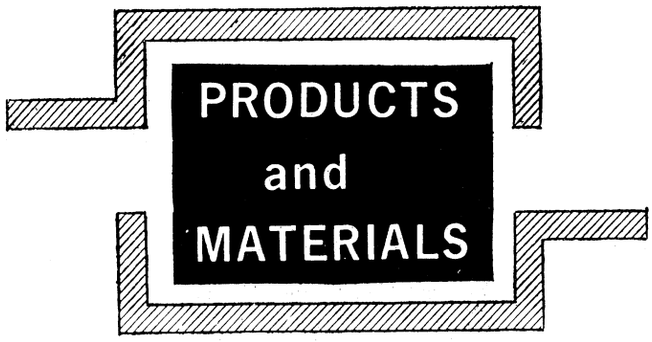

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Four-Function Spectrophotometer

The Spectro Plus combines four functions in a single unit. It performs spectrophotometry from 260 to 750 nanometers; fluorimetry, both front face and 90-degree angle; *p*H measurement; and measurements of dissolved oxygen concentration. Features include a light source and monochromator that yield usable radiation at a constant bandwidth from 260 to 750 nanometers. There are two recorder outputs. Haake, Temperature Control Equipment Division. Circle 781.

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 538A and 602A) and placing it in the mailbox. Postage is free.

—RICHARD G. SOMMER

Disposable Chromatography Columns

Disposable columns, packed with Sephadex G25 medium, are available in two models. The PD-2 has a volume of 1.5 milliliters and is equilibrated in 0.08-molar sodium hydroxide, *p*H 12. It is also equilibrated in citrate-phosphate buffer, *p*H 5. The PD-10 has a volume of 9.1 milliliters and is equilibrated in 0.9 percent sodium chloride. Applications include analyses of serum thyroxine and triiodothyronine, desalting, buffer exchange, and purification of small samples. Pharmacia Fine Chemicals. Circle 779.

Reach-In Incubator

Model 3916 has 104 square feet of shelf space, with up to 19 shelves. Temperature control is within 0.1°C over a range of 4°C above ambient to 60°C. Precise control at 37°C is assured when used with cell rollers, shakers, and stirrers; no refrigeration is required. A positive horizontal air flow system promotes uniformity to within 0.25°C at all shelf heights under full-load conditions. Forma Scientific. Circle 780.

Bench-Top Continuous Reactor

The model 403 Continuous Ergulator has a working volume of ¾ gallon (¼ gallon per stage). Maximum working pressure of this three-stage reactor is 450 pounds per square inch. Material in contact with chamber contents is 316 stainless steel. Units are available with jacketing and sparger in any stage and with variable-speed drive. Bethlehem. Circle 785.

Bench-Top Incubator-Shaker

Model G24 provides a wide range of closely controlled temperatures from near ambient to 60°C, with an accuracy and gradient within ±0.5°C. A large-capacity air-circulation system provides heat-up to 37°C in 10 minutes. The shaker drive imparts agitation in a range of speeds from 40 to 500 revolutions per minute. Rate of agitation is reproducible and is indicated by a tachometer. Optional accessories provide for cooling to below ambient temperatures and for such applications as the introduction of gaseous atmospheres. New Brunswick Scientific. Circle 790.

Filter Unit Holder

The filter unit holder is designed for use with Nalgene membrane filter units. It allows hands-off operation and prevents tipping of the units while they are attached to a vacuum source. The transparent acrylic construction permits full visibility of contents and easy access to the side arm of the filter unit. Nalge. Circle 791.

Developing Chamber for Thin-Layer Chromatography

A micro-developing chamber is available for use with coated, scored, 2.5 by 10 centimeter thin-layer chromatography plates. The chamber provides rapid equilibration and requires only small amounts of solvent. Each chamber is grooved to hold up to five plates at a time. Scored Uniplates, 10 by 20 centimeters, separate readily to yield eight plates suitable for developing in the chamber. Analtech. Circle 782.

Pocket Digital Thermometer

The Digital Dependatherm thermometer reads in degrees Fahrenheit or Celsius over the range from −60° to 2000°F or −50° to 1100°C in 1° increments. With special probes, the standard Celsius instrument reads from −30.0° to 200.0°C in increments of 0.1°. Accuracy is 0.5 percent of reading ±1 least significant digit. The standard surface temperature probe responds within 4 seconds. Atkins Technical. Circle 783.

PROM Programmer

The PR-2 PROM duplicator-tester-programmer incorporates basic parametric tests as part of the program-verification cycle. It tests output leakage and verifies programmed parts with worst case fanout loads, Vcc, V_{ol}/V_{oh} levels, and simulated temperature testing. As a

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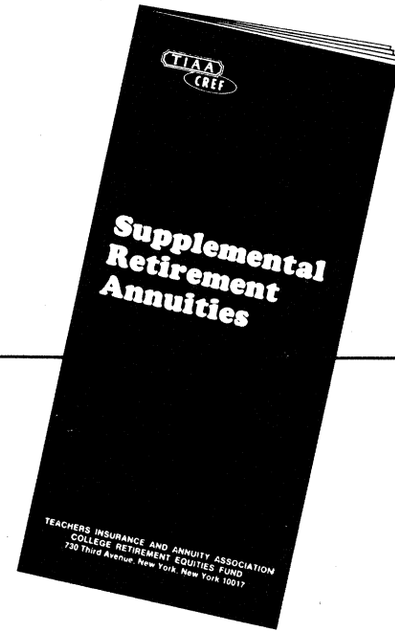

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duplicator, the PR-2 is designed for high throughput and may be interfaced with automatic handlers. As a programmer, the PR-2 is available with a hexadecimal or an octal keyboard. Spectrum Dynamics. Circle 784.

Microphotometer Peripheral for Microscopes

The Q-Stage system converts a microscope into a high-speed scanning microphotometer. This combines resolution of the microscope with a 70-millimeter-diameter format and 5-kilohertz sampling rate to provide real-time reduction of film and slide density data. One- and two-dimensional scans may be produced. Operator selects density range, number of contours, and histogram density. Photometrics Instruments. Circle 786.

Exhaust Fume Hoods

Air Saver fume hoods are designed to operate in air-conditioned laboratories without placing a burden on the air-conditioning system. Toxic fumes are evacuated without causing counterflow. These hoods are supplied with necessary wiring, plumbing, and supply and exhaust blowers. They are available in a variety of standard widths. Custom-sized units are also available. Lab Fabricators. Circle 787.

Hand-Held Digital Thermometer-Multimeter

The model 12T combines a digital multimeter and thermometer in one unit that features autoranging and autopolarity. It measures direct-current voltage from 1 millivolt to 750 volts, alternating-current voltage from 200 millivolts to 750 volts, resistance from 1 ohm to 19.99 megohms, and temperature from −55° to 153.5°C. The device operates on line current or with four rechargeable AA nickel-cadmium batteries. Logical Technical Services. Circle 788.

Temperature-Jump Spectrophotometer

System D-115 is suitable for studying fast reactions in solution. Temperature of a solution at equilibrium is increased rapidly by Joule heating. The device detects changes photometrically and determines the reaction-time curve. Relaxation time and time constant may then be determined. A temperature change of up to 15°C may be effected within 50 microseconds. Repeated measurements may be performed with a single 200-microliter sample. Durrum Instrument. Circle 789.

Literature

Syringe Type Automatic Sampler describes a unit for automatic sample injection in gas chromatography. Shimadzu Scientific Instruments. Circle 792.

Time Code Data Indexing Handbook presents theory as pertinent to various recording media. Datametrics. Circle 793.

Amino Acid Analyzers includes three models in two brochures. Design specifications, components, and typical results are presented. Beckman Instruments. Circle 794.

Optical Filters and Accessories describes a line of narrow-band interference neutral density, optical glass, and heat removal filters. PBL Electro-Optics. Circle 795.

Analytical and Top-Loading Balances includes the products of several manufacturers. Burrell. Circle 796.

Chromatography Chemicals and Accessories covers materials for gas, liquid, and thin-layer chromatographic separations. Analabs. Circle 797.

Infrared Analytical Accessories is devoted to products for spectroscopy. Photographs, descriptions, and technical specifications are included. Barnes Engineering. Circle 798.

On Polarization describes polarizers, depolarizers, rotators, crystals, and other accessories. Special Optics. Circle 799.

Portable Digital Thermometer gives complete specifications and information on applications for these devices. Precision Digital. Circle 800.

Thermometer Catalog lists glass-type, dial-reading, and other thermometers, hydrometers, and accessories. Brooklyn Thermometer. Circle 801.

Preparative Separation Principles in Biochemistry is a wall chart that explains features of various kinds of chromatography, electrophoresis, filtration, and devices used for these techniques. LKB Instruments. Circle 802.

UV-Visible Spectrophotometers lists a series of double-beam instruments and their accessories. Varian Instrument Division. Circle 804.

Liquid Chromatography is a handbook-catalog with discussion sections and instrument specifications. Hamilton. Circle 805.

LETTERS

(Continued from page 532)

exist and are always passive (that is, down the electrochemical gradient). If there is no electrochemical driving force, there is no net Na or K flux.

The most direct evidence (*2*) comes from experiments on giant axons of the squid (up to 1 mm in diameter). These axons can be cannulated, and about 95 percent of the cell plasm replaced by solutions of known composition. Normal action potentials are generated when the internal solution has a composition similar to that of the axoplasm. The fluxes of Na and K ions vary with the composition of the internal and external solutions and with transmembrane voltage (voltage difference between inside and outside solutions) in the direction predicted from the electrochemical gradients for these ions. A perfused axon can generate 300,000 action potentials. It is difficult to attribute these results to the residual cell plasm, and one is forced to a membrane theory of action potentials powered by Na and K gradients across the membrane. This and much other evidence firmly establish that excitable cells have Na and K ion activities which are respectively lower and higher than these activities in the solution bathing the cells, that is, Na and K ions are *not* in thermodynamic equilibrium across the cell surface. The energy for generating action potentials comes from the concentration differences of Na and K ions and these differences are maintained throughout life. Thus the necessity for (but not the existence of) ion pumps in excitable cells is established.

Those who contend that the properties of structured water are the complete or major explanation of Na and K ion distributions between cells and bathing media must not only "prove" that ion pumps are energetically impossible in normal excitable cells but must also provide an alternative equilibrium explanation of how excitable cells can produce net flows of Na and of K across their surfaces in the absence of electrochemical gradients of these ions. The latter is difficult, since the second law of thermodynamics apparently has to be violated.

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2. P. F. Baker, A. L. Hodgkin, T. I. Shaw, *Nature (London)* **190**, 885 (1961), *J. Physiol. (London)* **164**, 330 (1962); *ibid.*, p. 355; W. K. Chandler and H. Meves, *ibid.* **180**, 788 (1965).

RESEARCH NEWS

(Continued from page 566)

contact the neuroblasts temporarily wrap themselves around the fiber before undergoing differentiation and the migratory movements needed for the development of the mature *Daphnia* optic system. Levinthal thinks that the contact between the lead fiber and the neuroblasts is somehow involved in signaling the neuroblast to differentiate.

He says that these observations would not have been possible without three-dimensional reconstructions of the developing neurons at different stages of development. For example, the investigators would not have been able to distinguish in electron micrographs the stage in which the neuroblast wraps around the nerve fiber from ordinary nerve fibers with myelin sheaths. These sheaths are also composed of cells wrapped around nerve fibers.

Sydney Brenner and his colleagues at the MRC Laboratory of Molecular Biology in Cambridge, England, are now using computers to study the anatomy of the nervous system of a simple roundworm. The investigators have produced genetic mutants of the worms that have unusual behavioral patterns. They hope to determine how the neuronal anatomy of the mutants differs from that of normal animals and to unravel how genes control neuronal structure and function.

The techniques of computer reconstruction of neuronal structure are not limited to cells from simple invertebrate animals, however. Several investigators are using them to study the nervous systems of a wide variety of vertebrates including the frog, cat, rat, and even the human. One goal is to determine how environment affects the development of cells in various areas of the brain. For example, the visual responses of cats raised in a striped environment differ from those of normal cats. How these behavioral changes are related to neuronal structure is a major question that computer techniques may help answer.

Once a body of information about the structure of nerve cells and their interconnections has been acquired, whether from computer or other studies, it can be fed into an appropriately programmed computer in order to build models of whole areas of the brain. Llinas and A. Pellionisz of Semmelweis University Medical School in Budapest, Hungary, are using this approach to study the function of the frog cerebellum.

A great deal is known about the structure and activities of the different types of neurons that make up this portion of

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the frog brain, but much less is known about how their interactions affect the properties of the whole cerebellum. With a reconstruction of the anatomy and interconnections of the cerebellar neurons stored in the computer memory, it is possible to simulate the stimulation of a particular group of neurons and determine the response pattern of the neurons with which they connect. The results of the computer experiments can then be compared with the results of physiological experiments to determine how accurate the model is. The model can also serve as a guide for designing the physiological experiments.

In addition to helping neurobiologists gather quantitative information about the three-dimensional structure of nerve cells, computers are assisting in the tracing of nerve fibers and their connections in the brain and spinal cord. One way to trace fibers involves injecting radioactively labeled amino acids into the vicinity of the nerve cell bodies. After being taken up by the cell bodies, the amino acids are incorporated into proteins which are transported along the axons.

Location and quantitation of the label in serial slices of brain and spinal cord can be done by autoradiography. The sliced tissue is placed on slides and coated with a photographic emulsion. Wherever there is radioactivity, the emulsion is exposed and silver grains are formed. Locating and counting the grains on a slide is extremely tedious when done visually, but now David Whitlock of the University of Colorado Medical Center and Cowan and Wann have developed completely automatic computer systems for counting them. This process can be completely automatic because recognizing silver grains is a much simpler task than recognizing the more complex structure of neurons.

Both groups of investigators use television cameras to convert the gray tones of the autoradiographic image into a signal in which the grains appear totally black on a white background or conversely. The computer then counts and records the number of grains along with the spatial coordinates of the grain locations. Scanning the fields and focusing are completely automatic, although the operator can monitor the process. Whitlock says, however, that the system is accurate enough that counting can be done overnight without monitoring. This is important because scanning large fields may require several hours. The systems are adaptable to any kind of autoradiograph, not just those from nerve tissue.

—JEAN L. MARX

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(Continued from page 570)

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