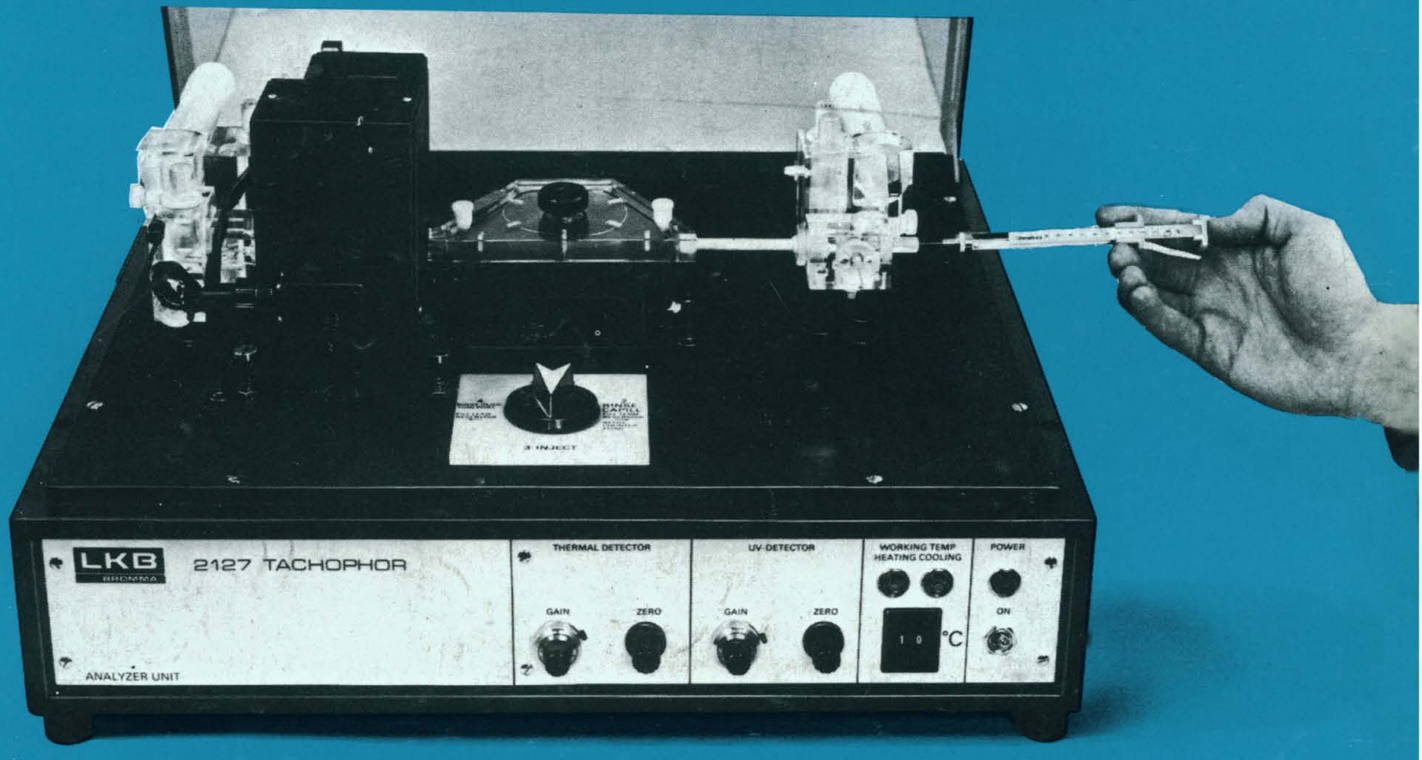
SCIENCE

21 May 1976

Volume 192, No. 4241

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

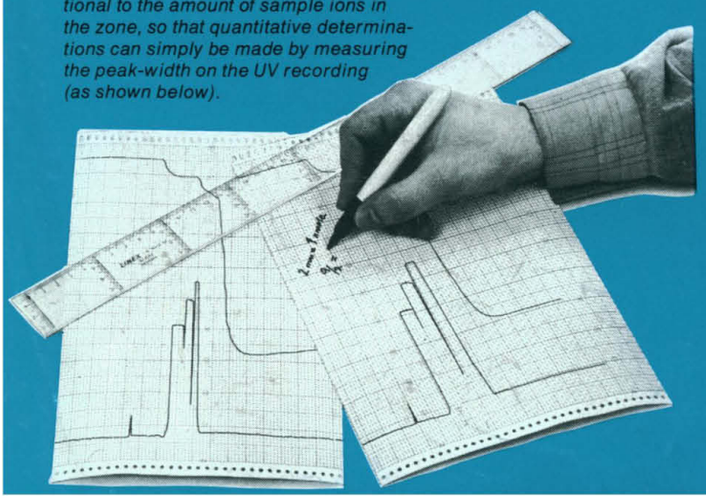
Analyse nanomoles of peptides and metabolites in 30 minutes...

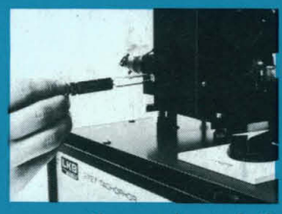


...with the LKB Tachophor

The LKB 2127 Tachophor utilizes the isotachophoresis principle for separating ions to give you results in 30 minutes or less. Ion species from metals to proteins can be separated easily and with high resolution. No pretreatment of the sample such as deproteinization or concentration is necessary. A typical separation of nucleotides or low molecular protolytes takes only 20 to 30 minutes.

The length of a zone is directly proportional to the amount of sample ions in the zone, so that quantitative determinations can simply be made by measuring the peak-width on the UV recording (as shown below).





A twin-detector system, UV and thermal, gives you a complete picture of an analysed sample in the 0.1 to 50 μl range. The twin-buffer system using Ampholine® carrier ampholytes as 'spacers' gives you excellent separation and resolution of difficult peaks. And no stabilizing medium is required as in other electrophoresis methods. The UV lamp used in the LKB Tachophor detector system is a plug-in type that is very easy to change. The LKB Tachophor is easy to operate and maintain, with a 4-position control and simple sample injection, plus counter-flow capability for analysis of large volume dilute samples. For more information, contact your LKB representative or write to us at one of the adresses listed below.

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Gradient Mixer GM-1
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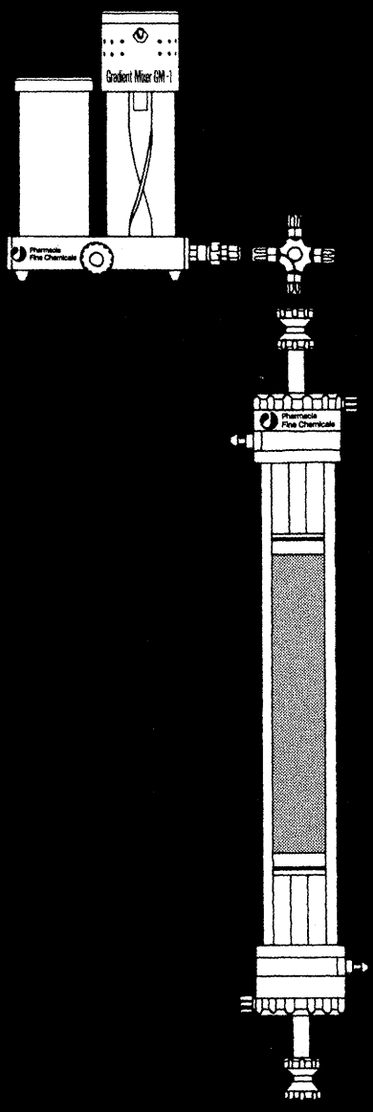
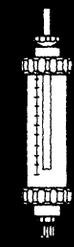
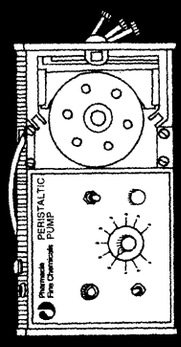
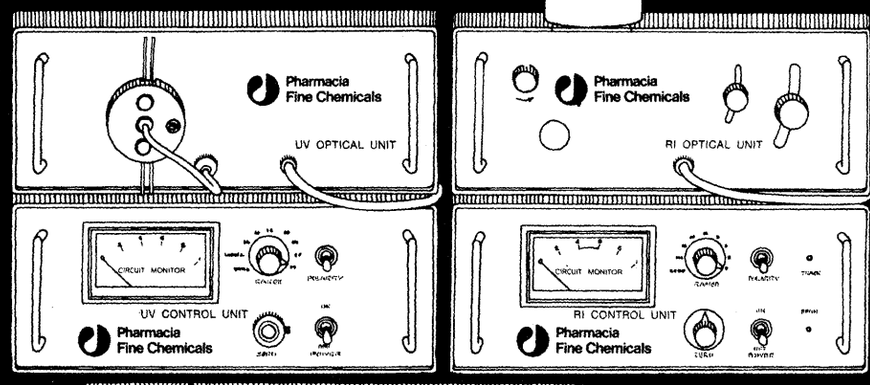
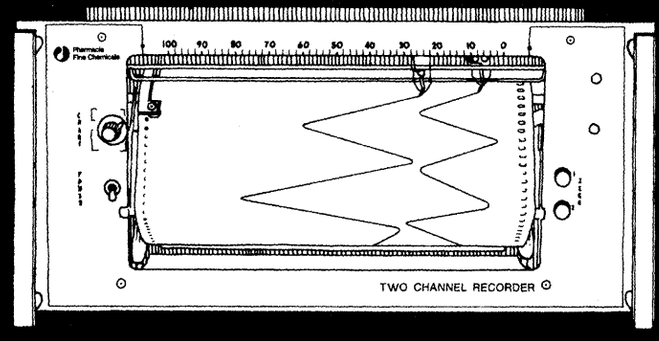
New!











Monitors and Recorders available only in U.S.A. and Canada.

Pharmacia Fine Chemicals
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Pharmacia Fine Chemicals

21 May 1976

Volume 192, No. 4241

SCIENCE

SCIENCE is published weekly, except the last week in December, but with an extra issue on the fourth Tuesday in November, by the American Association for the Advancement of Science, 1515 Massachusetts Ave., NW, Washington, D.C. 20005. Now combined with **The Scientific Monthly®**. Second-class postage paid at Washington, D.C., and additional entry. Member rates on request. Annual subscription $50; foreign postage: Canada $10, other $13, air lift to Europe $30. Single copies $2 (back issues $3) except Materials Issue (20 Feb. 1976) is $3 and **Guide to Scientific Instruments** is $6. School year subscription: 9 months $37.50; 10 months $41.75. Provide 6 weeks' notice for change of address, giving new and old address and zip codes. Send a recent address label. **Science is indexed in the Reader's Guide to Periodical Literature.**

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

REPORTS

The American Association for the Advancement of Science was founded in and incorporated in 1874. Its objects are to further the work of scientists, to facilitate cooperation among them, to improve the effectiveness of science in the promotion of human welfare, and to increase public understanding and appreciation of the importance and promise of the methods of science and human progress. Postmaster: Send Form 3579 to SCIENCE, 1515 Massachusetts Avenue, NW, Washington, D.C. 20005.

COVER

Adaptation of sketch of Holly Oak (Delaware) mammoth as carved on pendant. See page 756. [Sketch courtesy of B. J. Meggers, Department of Anthropology, National Museum of Natural History, Smithsonian Institution, Washington, D.C.]

The logical choice

One for the lab, one for the road

The Spectronic® 20 spectrophotometer is the one instrument students are most likely to encounter when they begin their laboratory careers. For that reason, many teachers choose this instrument for the laboratory course work. In fact, there have been more than 100,000 instruments sold worldwide.

The Spectronic 20 spectrophotometer offers continuous wavelength selection throughout its operating range of 340-950 nm. That means each determination can be performed at the precise analytical wavelength. Three simple controls make it easy to learn spectrophotometry. And educational manuals and teaching aids are available for curriculum planning.

We took the features of the Spectronic 20 spectrophotometer, the world's most widely used spectrophotometer, and packaged them in a miniature, precision grating instrument. The Spectronic® mini 20 spectrophotometer.

Small enough to fit in your pocket, the mini 20 yields lab quality results, yet is durable enough for student field trips. The rugged instrument body provides maximum impact and chemical resistance. For portability to remote field sites, for accuracy and precision away from the lab, the Spectronic mini 20 is the logical choice.

Come to think of it, the Spectronic mini 20 spectrophotometer is a pretty logical choice for the lab too.

For assistance in choosing equipment best suited to the needs of your courses or research, contact:

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Analytical Systems Division
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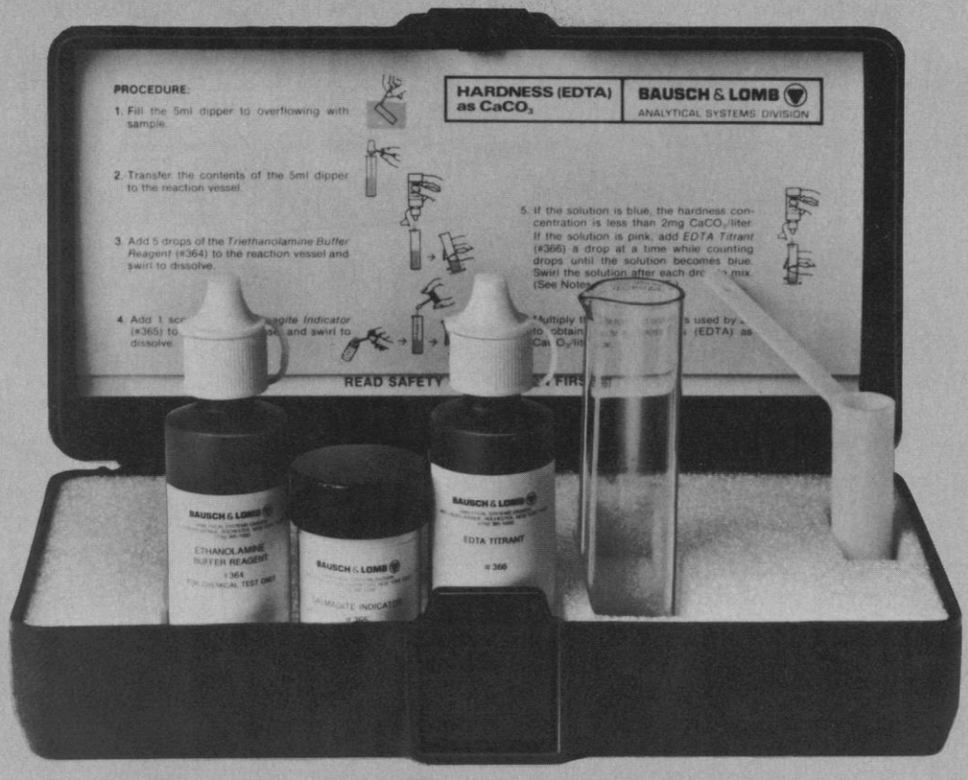
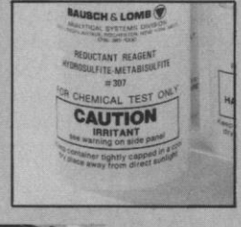
Tel: (716) 385-1000



The logical addition... SpectroKit™ Reagent Systems

Designed with teaching in mind

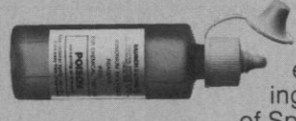
Open the rugged, portable case and you've got a compact, chemical storeroom at your fingertips. There's a wide selection of SpectroKit™ reagent systems available for nearly every aspect of environmental science. Each kit is a neat package containing the reagents, glassware, and detailed instructions for the most common water tests.



With chemistry in mind
Actual chemical names on reagent labels keep the essential chemistry lesson from being obscured. The simple, step-by-step illustrated instructions help students get correct results fast.

With accuracy in mind
A new calibration is supplied with every lot of reagents. Spectrophotometric kits are calibrated to the Spectronic® 20 and Spectronic® mini 20 spectrophotometers. Titrations use calibrated drop counting.

With safety in mind



All liquid reagents are packaged in non-spill containers. Full safety labeling is a unique feature of SpectroKit reagent systems. Students' hands need not contact the chemicals.

SpectroKit reagent systems help you get the most out of every contact hour with your students. For more information about SpectroKit reagent systems, write or call:

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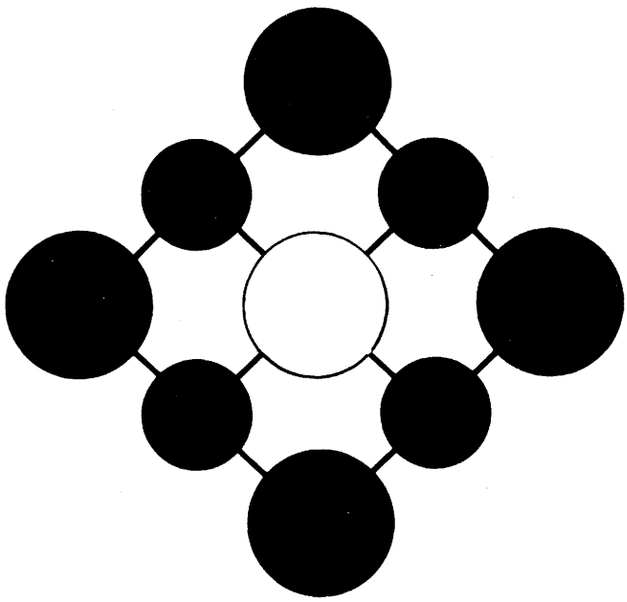

A New World of

Materials:

Renewable and Nonrenewable Resources

Edited by
Philip H. Abelson
and Allen L. Hammond

An important exploration of the new set of realities affecting the flow of raw materials—a probing of the increasing demand for them and the obstacles to their discovery and production.

A reliable flow of raw materials has been the fundamental factor in the health of the American economy and of the economies of all other industrial nations. While economic growth has begun once again in the United States and, more slowly, in Europe, it is predicated on a whole new reality of materials dramatically different from that of a decade ago. No longer can an abundance of basic commodities be taken for granted, and no longer can the supplying of any commodity be assumed continual. We have learned that the flow of existing materials is vulnerable to interruption by financial shifts, increased nationalization of foreign-owned properties, restriction of access to resources on public lands, and a host of other considerations born of the 1970's. In the development of substitute materials we must hurdle these obstacles and also adhere to new regulations for environmental protection.

In February 1976 *Science* devoted an entire issue to a critical in-depth look at these and related problems. The special issue contained 24 papers written by some of the country's foremost authorities. Thirteen more articles created by other, equally distinguished authors were added to the list, and the total is being published as a compendium to provide a meticulous look at *Materials: Renewable and Nonrenewable Resources.*

The compendium's authors probe the implications of national policy, energy constraints, environmental considerations on materials production and use, the perspectives in needs and supplies of resources, high technology materials, and renewable and reusable resources. They examine those materials issues most vital to industrial economics, the future of materials research, and the effect of the new realities on the quality of life.

The result is rare and refreshing—a detailed study which yields an identification of critical problems as well as the authors' consensus that, in principle, these problems are solvable. This overview must be studied by those involved in materials problems today, by those reaching for answers, and by all of us who will benefit from the solutions. Don't miss this vital collection of papers. A brief sampling of the compendium's contents reveals the importance of studying and dealing with these new realities.

Papers in the Compendium include

"Materials: Some Recent Trends and Issues"—Hans H. Landsberg

"The Age of Substitutability"—H. E. Goeller and Alvin M. Weinberg

"Forest Resources: An Overview"—James S. Bethel and G. F. Schreuder

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Please send me _____ copies of your latest Compendium *Materials: Renewable and Nonrenewable Resources.*

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Varian Announces... the Automatic Gas Chromatograph with a built-in nine-method memory

The Automatic Gas Chromatograph automates the entire gas chromatography process from injection and separation through peak measurement, calculation and final report.

It's truly automatic. Just turn it on, touch a couple buttons to tell it which analysis you're running and come back later for a complete report with the results edited and calculated up to nine different ways.

It's that simple because the Automatic Gas Chromatograph has a memory that will hold nine complete analytical method files. And each file will time program up to 127 events to control a specific analysis from start to finish.

Automatically controlled by the method file, here are some of the things the Automatic Gas Chromatograph will do:

1. It will wait until all operating parameters are at setpoint, and the baseline is stabilized, before beginning an analysis.
2. It will continuously monitor itself and give you a complete printout of all chromatographic conditions before the analysis. If any condition deviates from setpoint during an analysis, the final report will print the error conditions in red.
3. It will change and program column oven temperature throughout the analysis to optimize the separation.
4. It will select the detector range and zero the detector signal as often as needed during the analysis to obtain the most useful chromatogram.
5. Use its preset parameters to automatically quantitate the chromatogram.
6. Change peak processing parameters throughout the run to optimize integration of all types of peaks.
7. Edit the chromatogram . . . group peaks together and treat them as one, or suppress as many peaks as you want to anywhere in the chromatogram.
8. Calculate the analysis results by any or all of six methods: internal standard, external standard, calibration factor, relative response factor, area % and normalized area %.
9. Time program column switching and external events.
10. Send analysis results to another device for further manipulation.

When you add a Varian 8000 AutoSampler™ to the Automatic Gas Chromatograph, it can then also:

11. Handle up to 60 sample unattended and change method files automatically to handle different sample types with completely different programs.
12. Choose the correct injection volume and control the number of injections per calibration vial (for factor averaging) and the number of injections per sample vial.
13. Automatically check for errors in the analysis — missing peaks, wrong calculations data, etc. — and automatically advance to the next set of samples when a set error limit is exceeded.

It can give you many different reports from a single injection. Each method file can automatically call up another file and each linked file can edit, calculate and report the data from a single injection in a different way.

It's easy to work with. In addition to the central keyboard controls, each module also has its own independent manual controls which can be used as you develop methods or whenever it is more convenient.

Three basic models available. The Automatic Gas Chromatograph is a modular, dual-column instrument available in three basic detector-oriented models: (1) TCD, (2) Ionization, or (3) TCD/Ionization.

For the full story, contact your nearest Varian representative or circle *Reader Service No.* ***195.***

It improves accuracy, increases sample throughput and decreases the cost per sample.

New Varian Instruments for Research & Analysis

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Varian Announces the 3700... Not just a great gas chromatograph, the greatest gas chromatograph

This is the chromatograph that all the others have been leading up to. It's the one that chromatographers made for chromatographers. In a single instrument the 3700 brings together all the major chromatographic breakthroughs plus new applications-oriented design concepts in every component: new injectors, new detectors, new column oven, new programmers, new flow controllers, new electronics and new automation. The result: pushbutton simplicity combined with more capability to handle applications than ever before.

Modular flexibility. The 3700 is modular so you can easily choose a chromatograph for your specific application. You can begin at low cost with a basic dual-column unit and add capability as you need it. Or, you can start right now with the world's most powerful and versatile GC system.

Here are some of the 3700's new performance features:

New ESP* monitor continuously checks 3700 operating parameters for you — injectors, column oven, detectors, flows. And its bright self-diagnostic LED display continuously lets you know whether parameters are at their settings.

*Electro Sensor Panel

New digital controls let you set all chromatographic conditions in a few seconds. And there's no resettability error.

Extra-large, 1350 cubic inch, column oven with removable door gives you more room to install columns.

New Automatic Linear Temperature Programmer (ALTP). So good it will even operate the oven at 12°C above room temperature without cryogenic cooling, giving you increased resolution of low boiling components.

New non-contaminating flame ionization detector reduces down time and obtains detection over a wide range of sample concentrations.

Universal ionization detector bases let you interchange FID and ECD detectors yourself in minutes.

New flame-out indicator light and automatic reignite provide extra FID safety protection and help assure trouble-free automatic operation.

New pulsed ^{63}Ni electron capture detector has a linear dynamic range better than 10^4 and an MDQ better than 0.1 pg of lindane.

New differential electrometer will handle both FID and ECD.

New highest sensitivity thermal conductivity detector has a built-in amplifier that can amplify the bridge output signal to the recorder up to 10 times — greatly increasing capability to record and measure trace amounts.

New flow control convenience because all pneumatics are arranged in a large compartment planned for operator access.

New carrier gas flow stability and reproducibility because all critical flow control elements are isolated in an independently heated and thermostatted oven within the pneumatics compartment. This minimizes the effect of laboratory temperature changes and improves the precision and reproducibility of the data.

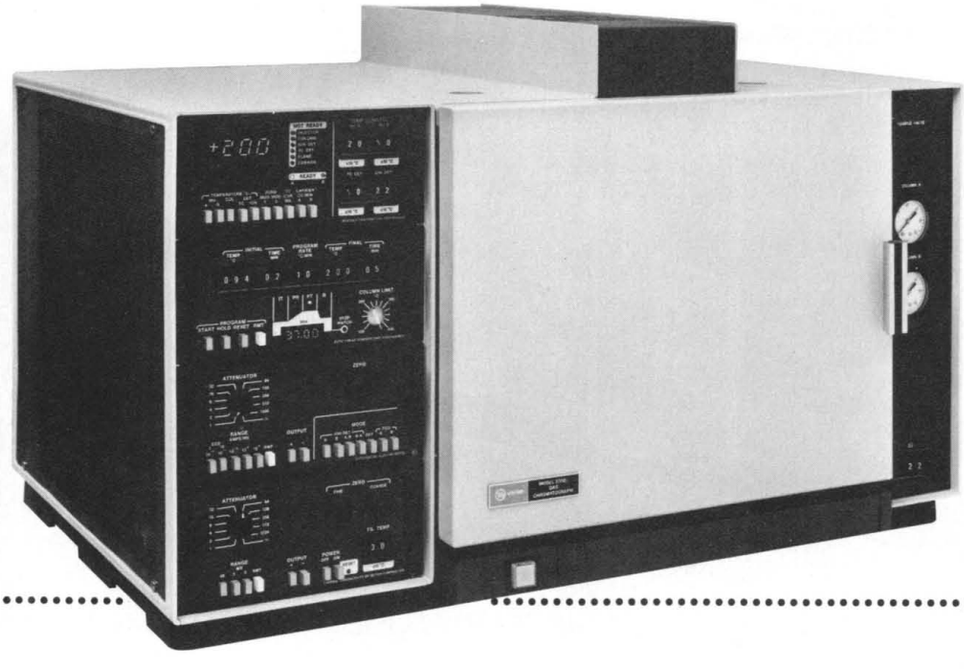
New flow control automation. New dual Automatic Flow Controller lets you dial-in carrier gas flow rates.

New versatile injector system has universal bases and quickly interchangeable injector bodies.

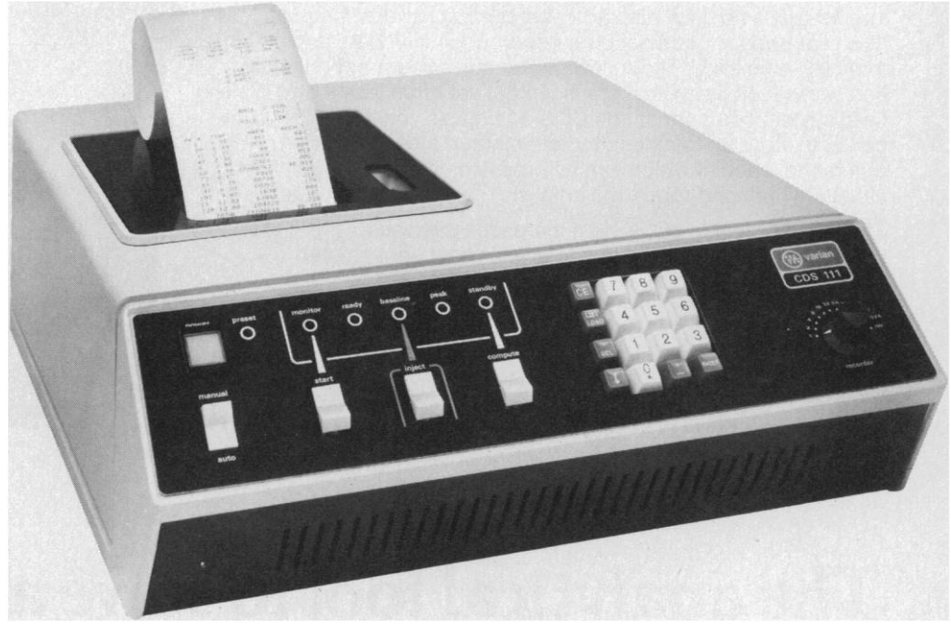
New cool injector septum holder reduces septum bleed. It also seals without compressing the septum so there's no danger of cutting off the gas flow and you don't bend needles on compressed septa.

New applications automation capabilities. The 3700 combines with the AutoSampler and CDS-111 Chromatography Data System to provide complete GC automation.

For full information on the greatest gas chromatograph ever made, contact your nearest Varian representative or circle *Reader Service No.* ***244.***



Varian Announces the CDS-111 Chromatography Data System... a better, easier way to quantitate your chromatograms



The CDS-111 is more than a powerful chromatography data system. It will automatically quantitate most chromatograms completely on its own. It will control an entire chromatography system—chromatograph, AutoSampler, valving, external events—in automatic closed-loop operation. It has large-computer power to store, for use on command, up to 9 (nine) complete method files each of which can be tailored to automatically control a complex analysis from start to finish. It will even link method files so that a single chromatogram can be automatically edited and calculated up to nine different ways. And the CDS-111 Chromatography Data System makes it all easy.

It automatically quantitates most chromatograms entirely on its own. You don't have to punch in sets of pre-run instructions. The CDS-111 already knows what to do. All the critical measuring parameters are factory preset and the CDS-111 automatically updates the parameters throughout the run to accurately quantitate most types of chromatograms. For unusual, or complex analyses, you can easily override the presets and set whatever values you need.

It accurately measures the areas of all types of peaks, simple and complex. For accurate, precise measurement of all true peaks, the CDS-111 continuously filters the noise from the chromatographic signal and keeps the peak detection threshold-to-noise ratio constant throughout the analysis.

The CDS-111 automatically calculates the results according to any of 6 (six) different methods: internal standard, external standard, calibration factor, relative response factor, area % and normalized area %. Through powerful file linking, any combination of these methods can be automatically applied to the data from a single injection and the results automatically reported in more than one form, e.g., weight %, mole %, and volume %.

The CDS-111 stores, for immediate use, up to 9 (nine) complete method files, each tailored to control a specific analysis. Files can be simple, using only their presets which will handle most analyses. Or they can be sophisticated, controlling the entire chromatographic process—the AutoSampler, the Model 3700 chromatograph, external devices, data acquisition, calculations and final report. You don't have to set up the CDS-111 every time you run a different sample. You can call up your stored file at the touch of a button.

The CDS-111 controls are simple. Four switches, a small keyboard and 6 (six) indicator lights give you complete control and you don't really need the keyboard at all unless you want to override the automatic settings, edit a report, or build or alter a method file.

The CDS-111 makes chromatography automation available to every lab. It interfaces simply with both gas and liquid chromatographs. Two different basic models are available, so you can choose a system that best meets your particular needs and budget.

For the full story contact your nearest Varian representative or circle *Reader Service No.* ***245.***

New Varian Instruments for Research & Analysis

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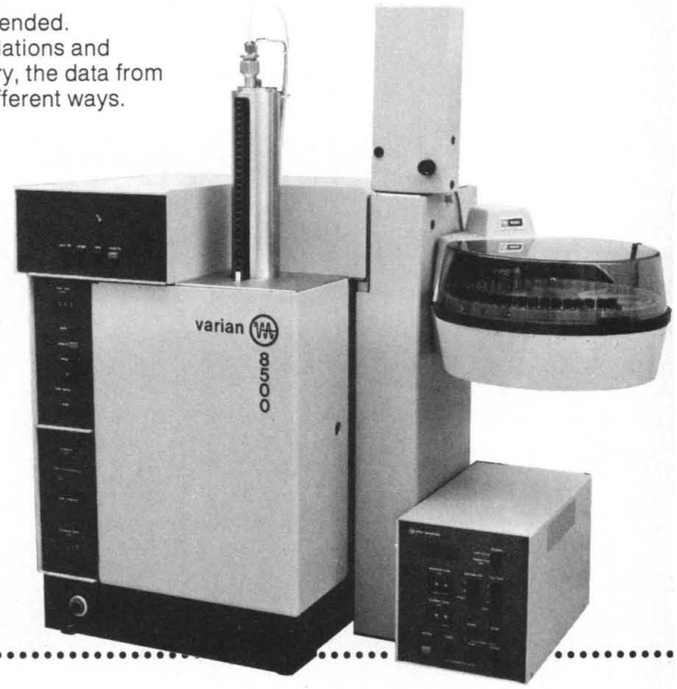
New automatic LC system for high sample throughput...

Varian's new Automatic LC System handles up to 60 samples unattended. It is completely automatic from injection, through separation, calculations and final report. And because the system has a big nine-method memory, the data from each injection can be edited, calculated and reported up to nine different ways.

The Varian Automatic LC System combines the new Model 8050 LC AutoSampler™ and the new CDS-111 Chromatography Data System with the Model 8510 Liquid Chromatograph in a fully integrated closed-loop system.

The system's positive displacement pump provides the pulseless flow required for good accuracy, reproducibility, detectability and high efficiency. The AutoSampler gives you great reliability and reproducibility with a coefficient of variation less than 1%. The third system component, the CDS-111, gives you large-computer power to store up to nine complete method files, for use on command, each of which can be programmed to automatically calculate, edit and report the analysis (see preceding page).

The new Automatic LC System increases throughput, improves accuracy and decreases your cost per sample. For full information circle *Reader Service No.* ***246.***



The analytical tool to solve almost any LC problem...Model 8520 LC/Varichrom™

This is the most capable liquid chromatography system available today.

The 8520 Liquid Chromatograph is unsurpassed for analytical and preparative work. The new Varichrom is a nearly universal detector covering the entire UV-Vis range from below 200 nm to 720 nm.

The chromatograph's superior syringe pump provides precisely controlled pulseless flow and low noise so you can detect and measure the smallest quantities. It gives you the flow rates and pressures you need to use the most efficient columns. And the 8520 has the gradient capability you must have to separate the most complex mixtures.

Varichrom, with its extended wavelength range, lets you optimize for most organics and permits monitoring many new compound classes such as lipids, mono-olefins and carbohydrates.

Varichrom couples directly to the 8520 in a configuration that eliminates dead volume and preserves peak resolution. For full details on this capable combination circle *Reader Service No.* ***247.***

If you designed your own NMR system, which features would you choose?

To expand experimental capabilities in NMR spectroscopy has been Varian's foremost task ever since we designed the first commercially available NMR spectrometer, back in the mid-fifties. Varian NMR spectrometers continually undergo additional development. Important new features are incorporated, new accessories are designed, and new techniques are made possible. In the past few months, we've introduced more new NMR capabilities than in any other year!

Of course, you'd expect no less from the world's leading manufacturer of NMR instrumentation, just as you'd expect the wide range of basic spectrometers Varian offers: from the lowest-cost 30-MHz EM-300X to the powerful 300-MHz Supercon, with the time-proven 60-MHz T-60A in between. The fact is, such diversity of NMR capabilities, together with the exceptionally wide range of new features, lets you practically design your own system. First, select from the new features the ones that will best suit your requirements, then, to receive details, circle the appropriate Reader Service Number.

XL-100A

For high-resolution NMR at 23.5 kG over a broad range of experimental needs: XL-100A. A most flexible research instrument, consistently at the forefront of innovative design and advanced performance. Newest features and accessories include:

- **Increased Sensitivity** — betters ^{1}H specifications to 70:1 (5-mm sample) and 280:1 (12-mm sample).
- **1-mm Microinsert** — ensures best possible signal from samples as small as 1 microgram.
- **18-mm Probe** — provides routine natural-abundance ^{13}C spectra at millimolar concentrations.
- **Gyrocode Observe** — adds more than 30 nuclei to the experimental repertoire. Among the nuclei that can be observed: ^{2}H, ^{13}C, ^{15}N, ^{17}O, ^{23}Na, ^{27}Al, ^{55}Mn, ^{195}Pt, ^{199}Hg.
- **Single-Sideband Filter** — cuts data acquisition time in half by eliminating the noise which normally folds into an FT spectrum.
- **FT Disk Accessory** — permits acquisition of high-resolution FT spectra by expanding the data table to 32K words.

Circle Reader Service No. ***248.***

CFT-20

For high-resolution, multinuclear research work with pulsed FT and observe frequency of 20-80 MHz: CFT-20. New features and accessories:

- **Increased Sensitivity** — betters ^{13}C specification to 100:1 (10-mm sample), 70:1 (8-mm sample), and 30:1 (5-mm sample).
- **Double Irradiation Accessory** — permits irradiation of specific regions in the spectrum while observing other regions.
- **Homospoil** — eliminates the effects of residual X-Y magnetization and thus prevents distorted line intensities for a cleaner spectrum.
- **^{1}H and ^{31}P Observe** — offers the ability to obtain high-resolution spectra of these two nuclei, in addition to ^{13}C.
- **Flexible-Disk Data System** — provides ultra-convenient storage and retrieval for data and program; dual system offers over 4-million-bits capacity on two disks.
- **Microsample Probes** — ensure best possible signal from samples as small as 1 microgram.
- **Single-Sideband Crystal Filter** — increases signal-to-noise ratio of systems in the field by approx. 40%.

Circle Reader Service No. ***249.***

EM-390

For high-resolution research and routine proton studies at 90 MHz: EM-390. Low-cost NMR spectrometer, now available with these features and accessories:

- **Spin Decoupler** — for irradiation of specific spectral regions while observing other regions.
- **Variable-Temperature Accessory** — for study of temperature-dependent phenomena such as kinetics and chemical equilibria.
- **^{19}F Observe** — delivers high-resolution spectra from fluorine-containing compounds at 84.67 MHz.
- **Digital Signal Averager** — enhances weak NMR signals by storing data from successive scans and averaging the accumulated information.

Circle Reader Service No. ***250.***

EM-360A

For high-resolution, routine proton spectroscopy at 60 MHz: EM-360A. Low-cost instrument, standard-equipped with these new features:

- **Increased Sensitivity** — boosts specification to $\geqslant$ 25:1.
- **Improved Shielding** — eliminates magnetic and rf disturbances.
- **New Temperature Control** — uses improved oven controller for greater temperature stability.

Circle Reader Service No. ***251.***

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Varian Instrument Division
611 Hansen Way
Box D-070
Palo Alto, CA 94303

The AMINCO-BOWMAN™ Spectrophotofluorometer

now features the

NOZONE™

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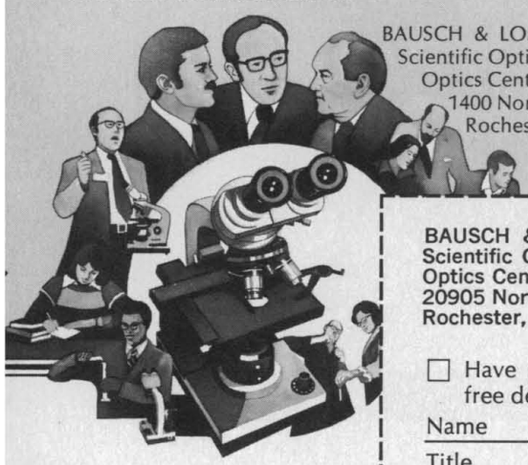

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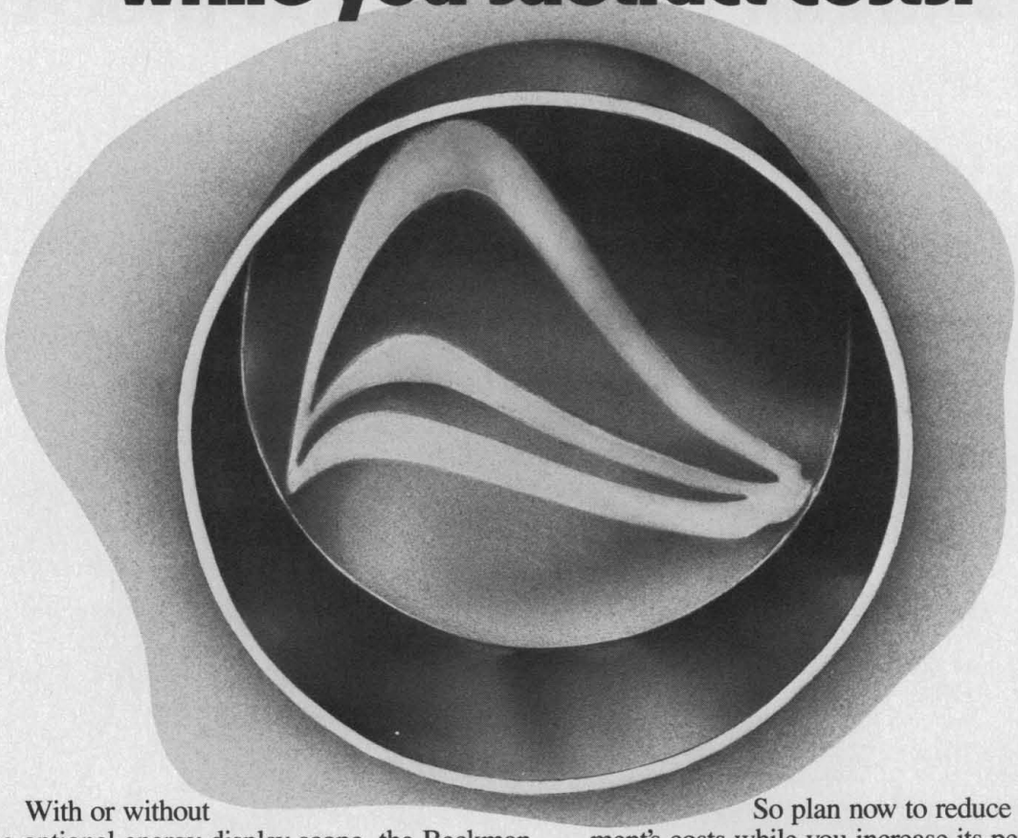

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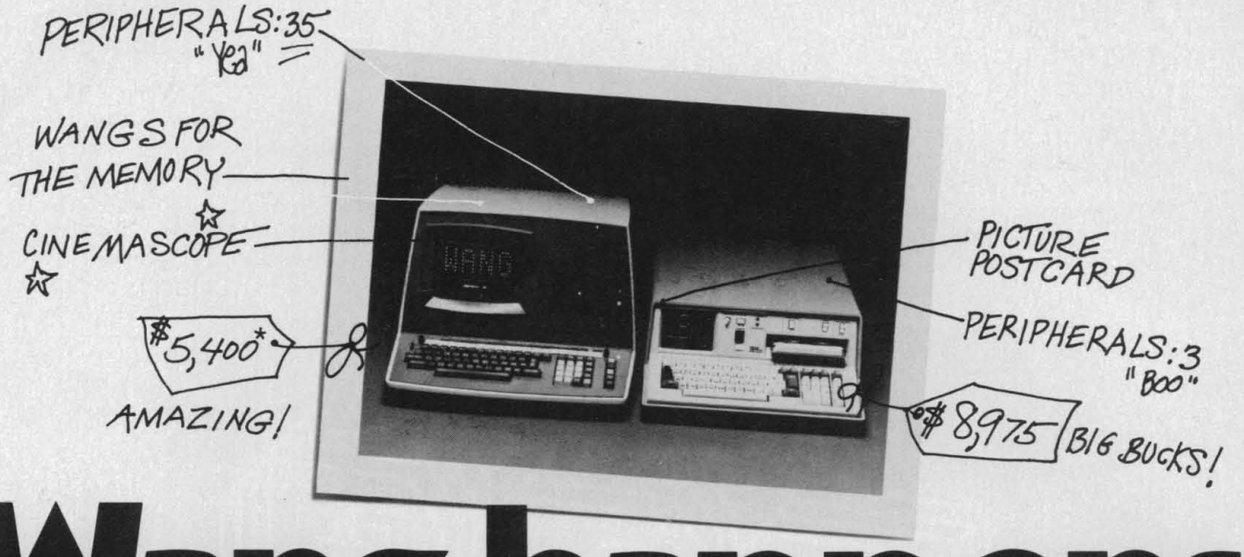

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LETTERS

An Alternative Case for Sociobiology

Recently, the topic of sociobiology has been the target of much criticism and heated debate (News and Comment, 19 Mar., p. 1151; Letters, 30 Apr., p. 424). Discussion has centered on the book *Sociobiology: The New Synthesis* by E. O. Wilson (*1*), which has been attacked as a dangerously deterministic document with strong political overtones by the Science for the People group (*2*) and defended by its author (*3*).

When the smoke is cleared away, this debate is seen to center largely on the question of the limits of plasticity of human behavior—the degree to which genetic principles of evolutionary adaptation can be applied to the social behavior of man. The attack of the Science for the People group amounts to a resurrection and a rehashing of the old "innate versus learned" controversies that raged during the early phases of the development of the field of ethology. Those debates, although politically enlightening, proved largely unproductive scientifically and, in fact, hampered progress in the fields of both psychology and ethology. It would be a shame if the major contributions and potential importance of the new field of sociobiology were to be lost behind a diatribe of "determinism-environmentalism" rhetoric.

The field of sociobiology did not originate with E. O. Wilson's book. Rather, it has its roots in over a century's accumulation of field natural history studies on a wide range of animals. These studies, when viewed in terms of modern theoretical ecology and population genetics, provide the data base from which the general theories of sociobiology are emerging.

One of the strengths of this field is its ability to interpret and partially predict the social structure of a species on the basis of a limited set of environmental or ecological variables—the type of food resource together with its degree of stability and predictability; the dispersion pattern of different resource bases in both time and space; the types and strategies of potential predators or parasites and means for counteracting them; the need (or lack thereof) for rapid information exchange about the environment. These and other ecological parameters impose limits on the range of types of social organization that will be adaptive. With differences in the dispersion of a critical resource, the availability of mates, and other factors, optimal social strategies shift, resulting in a fine tuning of social organization to ecological constraints.

The importance of these predictive hypotheses lies in their broad applicability across phylogenetic lines. Similar ecological determinants seem to apply when we examine such diverse groups as dragonflies or frogs, coral reef fish or marine birds, tropical bats or weaver birds, African ungulates or primates (*4–6*). Animals faced with similar ecological "problems" exhibit a predictable convergence in their "solutions," as shown in their social organizations.

The Science for the People group is correct in noting that evolutionary biologists generally assume an observed behavior is the result of natural selection operating at the level of the individual. But the case for the importance of sociobiology need not rest on any premise of rigid genetic determinism of behavior. It is becoming increasingly apparent that social organization, even in so-called "lower" forms, exhibits a surprising amount of plasticity. What adds strength to the hypotheses of sociobiology is that often the form of this plasticity as well as the conditions under which it occurs are, in themselves, predictable. Thus the spatial organization of certain species may shift from being aggressively territorial to being nonaggressively nomadic or gregarious because of changes in predation pressure or in the economic defendability of certain resources (*4, 6, 7*). In fact, the shift from territoriality to nonterritorialty in some species can be predicted with quantitative precision (*8*) and, in others, can be experimentally induced through manipulation of the distribution of critical resources (*9*).

Similar plasticity occurs with respect to mating systems. Shifts between monogamy and serial polygyny and polyandry occur, as do shifts between serial polygyny and the formation of leks (or communal display grounds). Again, these shifts occur where they would be predicted on the basis of changes in predation pressure or in the potential for individual monopolization of critical ecological resources (*10*).

The observed plasticity of social behavior should serve as a warning to those who propose overly simplistic genetic explanations for such behavior patterns as monogamous mating systems or territorial imperatives in man. Indeed, it is unfortunate that many early popularizers of animal behavior did precisely this. But most of these writings preceded the synthesis stage of sociobiology, and few, if any, social behaviorists today would adhere to such strict genetic determinism.

Different species are expected to be

differentially flexible with respect to making rapid changes in social organization to meet environmental changes. The more stable and predictable the long-term environment for a species, the more we may expect genetic determinism of behavior. Wilson describes this in terms of the "phylogenetic inertia" that an animal carries with it. In species whose environment is highly variable or unpredictable or which show tremendous cultural plasticity (including, but not exclusive to, man), we expect this phylogenetic inertia to be less pronounced and the potential for rapid behavioral change to be greater. But this does not mean human societies are fundamentally different from all other species and are totally free from ecological constraints. Most human societies are still faced with ecological "problems," and we still should expect a limited range of resulting "solutions." Knowing whether the resulting social organization is arrived at through long-term genetic change by natural selection, through individual trial and error learning, or through a cultural transmission of the optimal strategies of resource utilization is not the crux to understanding the potential importance of sociobiology. An organism that has the cultural flexibility to adapt its social organization to changing ecological pressures merely has the capability of arriving at a more optimal social organization more rapidly than one that is locked into the slower process of evolutionary change in gene frequencies dictating changes in its behavior.

Indeed, studies of human societies that still retain a close connection to their environment tend to reinforce the predictions and findings of sociobiology. Understanding human resource bases in ecological terms (type, abundance, dispersion pattern, long-term predictability or reliability of food resources, and so forth) is proving valuable in explaining such features of human social organization as group sizes, types of interactions between neighboring groups, mating systems, and optimal foraging strategies (*11*).

The problems and challenges of sociobiology come in attempting to apply it to modern, industrialized societies. Here man no longer lives in harmony with his environment. Western man is buffered from the ecological consequences of his actions, and hence the feedback mechanisms (whether genetic or cultural) that normally promote changes in social organization and "adapt" it to the critical limiting features of the environment are broken. The problem of "adaptation" when such feedback loops are broken was eloquently discussed by Hardin in "The tragedy of the commons" (*12*). The resource bases of modern man are exceedingly complex and highly diversified. Technology and industrialization, exploitation and colonization, and mobile transportation of resources all complicate the picture to the point where sociobiology, at least in its current state, is unable to make strong statements or predictions concerning "optimal and nonoptimal" types of social structure. But this does not decrease either the potential political significance of sociobiology or its possible misuses.

The Science for the People group correctly point out the dangers of misusing biological determinism to justify the status quo. But to whatever degree phylogenetic inertia is of importance in humans (that we are carrying a genetic-behavioral heritage molded by natural selection to be adaptive to a hunting-gathering, preurban existence), it would be unwise to cease studies of sociobiology or to ignore the biological consequences of politically imposed social structures—regardless of their ideology.

In contrast to the Science for the People group, I see both the strengths and the dangers of sociobiology as extending far beyond the question of the genetic bases of human behavior. Suppose that studies ultimately reveal that human social behavior is infinitely malleable (which I strongly doubt). If future advances in sociobiology allow us to become increasingly precise in predicting the fine structure of social organizations of animals on the basis of ecological constraints, then why couldn't these principles be applied in reverse? Resource bases or distributions could be manipulated in an attempt to shape a particular, "desired" form of social organization. Who, in this case, should have the power to dictate what the politically or morally "optimal" type of society should be?

These are not hollow questions. In many Third World countries, human cultures exist whose social organization is in tune with their environment. As these nations attempt to rapidly enter the world of 20th-century technology, many industrialization and agricultural reforms are initiated. These frequently result in massive changes in the distribution of the resource bases of the country and lead to significant changes in the potential for monopolization of these resources by certain individuals or groups. This, in turn, can lead to increasingly stratified and nonegalitarian societies. Such changes are occurring constantly, in all corners of the world. Future sociobiological findings could be of impor-

tance in helping plan the types of technology that we should export and the detailed manner in which they could be applied in order to minimize the frequently chaotic changes they produce in the cultures of the recipient nations.

Neither the potential benefits nor the political dangers of sociobiology rest solely with the issue of genetic determinism of human social behavior. The best formula for increasing our understanding of sociobiology, while at the same time safeguarding against political misuse of information, lies in promoting basic research in this new field, and in disseminating the findings to as broad an audience as possible.

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Plutonium and Christian Ethics

Regarding the article "Plutonium: Its morality questioned by National Council of Churches" by Philip M. Boffey (News and Comment, 23 Apr., p. 356), I wish to inform your readers that I did *not* participate in the colorful debate at the Riverside Church in New York City on 28 January "appointed by the Atomic Industrial Forum" as the article says, but rather representing myself, at my own expense.

Since last fall, I have been actively assessing the views of both the World Council of Churches and the National Council of Churches on these matters and communicating the substance of them to the U.S. Congress, the Energy Research and Development Administration, the National Academy of Sciences, and the National Academy of Engineering.

The World Council's work is by far the best; they did not (contrary to the implication in Boffey's article) make a colorless "neutral" report; they said that they're not finished yet. Their working papers and report will be published as a book, but meanwhile can be found in issues 20 (May 1975) and 21 (October 1975) of their occasional journal *Anticipation*. They are excellent reading for all who seriously ponder these matters. Their interim report in issue 21 answers some of the questions and raises others (for example, What are the world's options?) and tries earnestly to structure each part of the debate so that it can be constructively continued.

The National Council's work is too narrowly constructed and very hubristic, as was also pointed out by the ethicists Maxey, Shinn, and Williams at the 28 January debate. It fails to introduce in any organized way any principles of ethics, Christian or otherwise, but builds its persuasions on the base of its own conclusions—a proclivity discussed in ancient times and found wanting (*1*).

DAVID J. ROSE

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1. Jer. 23 : 21, "I have not sent these prophets, yet they ran; I have not spoken to them, yet they prophesied."

Boffey's report on the National Council of Churches' position on the "plutonium economy" was a sympathetic and balanced document. It started with a provocative quote from material I presented to the National Council's General Board complaining about their illegitimate ecclesiology, but regrettably omit-

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ted a technologically relevant point. From the quote, your readers could draw the erroneous conclusion that I am an advocate of the breeder. My position has been that by far the most cost-effective R & D to balance energy supply and demand in a free enterprise economy is a set of nationwide programs to actively encourage nonuse, even beyond conservation. By coincidence, this position is also the only essential element of energy policy which can be unambiguously connected to Christian ethics via the imperative to share.

Church bureaucracies, like others, prefer to pronounce on (scientific) subtleties well beyond their ken (and involving only the sixth derivatives of moral imperatives), which requires no action on *their* part. They avoid the obvious behavioral corollaries of their main hypotheses, which call for sacrifice, however minor, on the part of their constituencies. Scientists should easily recognize such proferred "cheap grace" as the modern day analogue of the "perpetual motion machine."

RUSTUM ROY

Materials Research Laboratory, Pennsylvania State University, University Park 16802

Contrary to the implication in Rose's letter, the National Council of Churches did in fact allow the Atomic Industrial Forum (AIF) to choose the three pronuclear experts to participate in the debate, and the AIF did in fact name him as one of the three, after first getting his permission to do so. A "chronology" of events published by the church council on 22 March states that Rose was "chosen by the Atomic Industrial Forum," and a report on the debate published by the AIF on 5 February states that the three pronuclear speakers were "coordinated by AIF." As for the World Council of Churches' report, the judgment that it was "neutral" on the nuclear issue was made by National Council of Churches staffers.

—PHILIP M. BOFFEY

Nuclear Power Decisions

If the United States were a more nearly ideal representative democracy, I would agree with Brewster C. Denny's opinion (Letters, 16 Apr., p. 202) that use of the direct ballot referendum or initiative is an inappropriate way of dealing with an issue as complex as the regulation of nuclear power plants, and that the appropriate way would be through elected representatives who reach their conclusions by means of reasoned debate. The problem is many people fear that our elected representatives may not be basing their conclusions primarily on the issues, but rather on promises and threats from special interest groups. As long as there is any reasonable suspicion that our elected officials are responding to these political pressures (and there are certainly grounds for such suspicions today), I cannot blame the supporters of the California initiative for taking an issue like nuclear power, which (because of the potential profits involved) is so susceptible to political pressures, directly to the people.

ART HOBSON

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While Denny is factually accurate regarding the way our political process works, he nevertheless misses the point.

He does not believe that informed debate on the technically complicated issue of nuclear power is possible and that, considering the risks and the economic alternatives, such a debate would not be likely to "produce an appropriate result." This indeed is the heart of the issue; but (i) Can we assume that informed debate will occur in Congress? and (ii) If so, will that debate be any more likely to produce "an appropriate result" with necessary consideration for risks as well as economic alternatives?

At a time when confidence in representative government is so low, it is no wonder that people are trying to bypass that body of decision-makers, especially on such an important issue. Just a quick look at recent "representative" decisions on environmental issues alone, from food quality and air and water pollution to atomic energy, indicates that these decisions have been made with much more concern for economic alternatives than for risks. Our understanding of the risks is so limited that extreme caution is the only prudent course. The emotion stirred by the nuclear power question is rooted in a perception of deliberate disregard by planners for the possible risks.

We must not rush to dependence now on an inadequate and potentially dangerous technology and build up a debt we might have to pay for a million years, when, in 50 years, the development of this technology may be either unnecessary or certainly much more safe. The problem is not the development of nuclear power per se but the push to proliferate it at a time when the safety of the technology is at best doubtful.

JAMES STEPHENS

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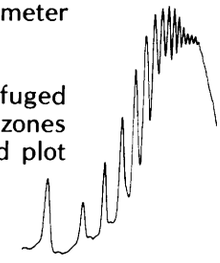

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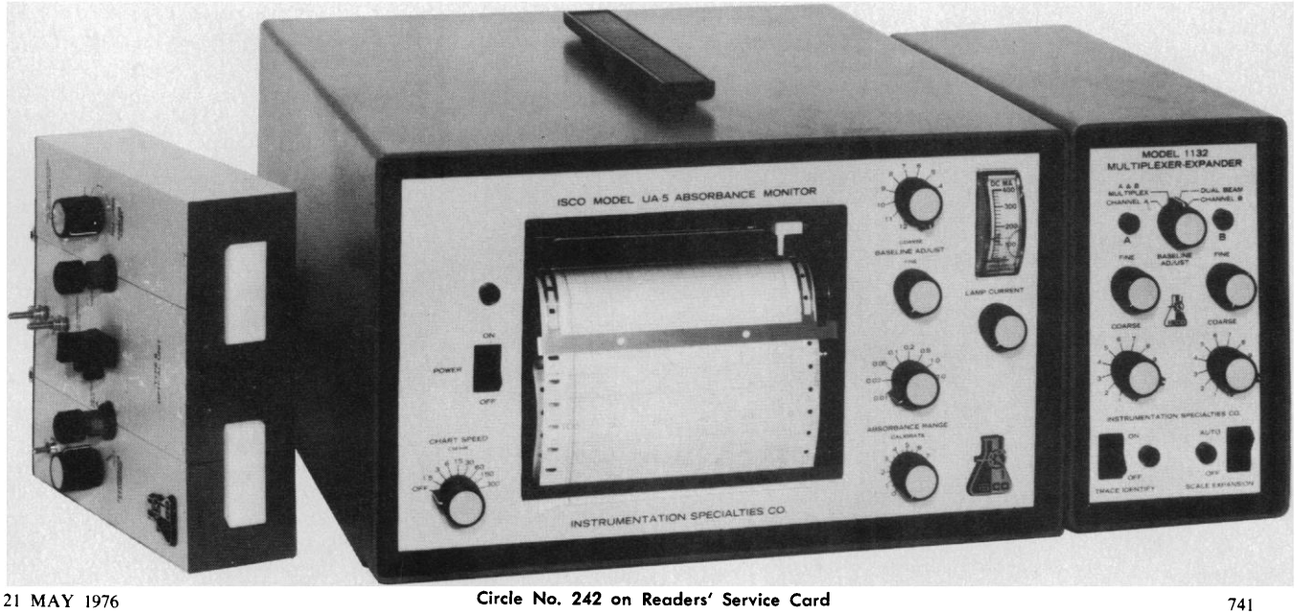

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21 May 1976, Volume 192, Number 4241

SCIENCE

Basic Research and Congress

If scientists needed another reminder that there are no certainties in the relationship between government and science in the United States, a House appropriations subcommittee furnished it on 30 April. The subcommittee trimmed more than $50 million from the President's basic research request for the National Science Foundation, and in one stroke—for the second year running—undid the prospects for recovery from eight years of declining investment.

Meanwhile, on another front the Congress was settling its differences over a bill to restore an Office of Science and Technology Policy to the White House, and downtown a signing celebration was being orchestrated for the Rose Garden. The contrasts speak for themselves. It is obvious that basic science is in trouble with Congress, and that the past four years of debate over national science needs and goals has not sufficed.

True, the troubles of the NSF during the past year or two may well have something to do with the current budget outcomes. NSF has been mauled remorselessly by its congressional pursuers, and its supporters in Congress have been obliged to come to its defense time and again. In this atmosphere, the cut in basic research funds can be interpreted as punitive. But punitive budgeting of this kind is a heavy-handed form of legislative discipline.

Consider the swath that the House subcommittee cut: $27 million was subtracted from support for mathematics, physical sciences, and engineering; another $13 million came out of astronomy, atmospheric research, and oceanography; $16 million more was stricken from the biological and behavioral sciences. Curiously enough, the reductions resemble the amounts that the President decided to add to the NSF budget at the very end of his decision-making, when he was satisfied that the overall federal budget could be held within his predetermined totals. It was this increase which made it possible for him to point to a rise of 11 percent in support of basic research, signaling a reversal of the previous trend in which federal support for research at colleges and universities had declined more than 20 percent from 1968 levels.

In our editorial of 6 February 1976, we warned that the President's budget for basic science deserved credit for its good intentions but that the response by the Congress was problematical. So it has proved to be. Although the full House Appropriations Committee could restore some or all of the current subcommittee cuts when it meets on 1 June, that it will do so is very unlikely in the absence of a storm of reaction from the country. There is another aspect to all of this. Twice in a row President Ford has gone to the Congress with proposed budget increases for basic research. If he is rejected the second time around, will he or his successor care to try again?

The AAAS is on the verge of publishing its first analysis entitled *Research and Development in the Federal Budget*, which will be largely a description and an assessment of the maze of decision-making stages through which science budgets must find their way. It is anything but dull reading. As we struggle to improve what is called the public understanding of science, we must also try to upgrade the scientists' understanding of government's behavior, including the uses of congressional budget power.

Over the decades, the Congress has done much to see to the progress of scientific research and development. That is beyond dispute. The research capability of this country will not be dismantled if the present action in the House stands. The point is that *a decline of nearly ten years duration in the resources allocated to basic science* is a very serious matter, and the current cuts will deepen and prolong that decline. In this light, the timing of celebrations and garden parties has more than a touch of the grotesque.

—WILLIAM D. CAREY

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percent level typically seen in vehicle exhaust gas, the maximum HCN is further decreased to 2 ppm, as shown in curve 3. Curve 4 represents data measured in typical synthetic exhaust gas (1.5 percent CO, 0.5 percent H_2, 12 percent CO_2, 0.1 percent NO, and 10 percent H_2O). Data are given under these conditions for the untreated PTX, treated PTX (for low NH_3 formation), and the base metal GEM 68 NO_x reduction catalyst. At typical catalyst operating temperatures (650°C) in simulated exhaust gas, HCN formation is about 0.5 ppm over the NO_x catalyst system. The data of Fig. 1 clearly indicate that H_2O inhibits the formation of HCN.

Laboratory experimentation has shown that HCN can be formed over a noble metal catalyst under reducing conditions. However, when the gas approximates vehicle exhaust, under net rich carburetion conditions, very little HCN is formed, typically less than 1 ppm. The exhaust gas components that act as HCN promoters are, in order of increasing effectiveness, NO, NH_3, CO, and H_2. On the other hand, the exhaust components that are HCN inhibitors are, in order of increasing effectiveness, CO_2, H_2O, O_2, and SO_2.

Actual vehicle tests have also been conducted to verify the laboratory data and to assess the possibility of the formation of HCN in catalyst-equipped vehicles. A 1975 California Chevrolet Nova (350 cubic inch displaced) was fitted by Gould with a GEM 68 dual-bed catalyst system calibrated to meet the 1978 standards of the Clean Air Act, that is, 3.4 g of CO per mile (2.1 g of CO per kilometer), 0.41 g of hydrocarbon per mile, and 0.4 g of NO_x per mile. The vehicle was operated with an air pump to provide about 5 percent O_2 to the oxidation catalyst and was driven on a chassis dynamometer according to the 1975 Federal Test Procedure schedule (*3*), with Indolene containing 50 ppm of sulfur used as the test fuel. The driving cycle is typical of normal urban driving with accelerations and decelerations giving an average speed of about 25 mile/hour (40 km/hour). In addition to the normal driving mode, a worst-case situation was also simulated when the vehicle was driven at high speed (50 mile/hour) with heavy choke. In the worst-case situation the exhaust contained 6 percent CO and 0.06 percent NO_x. This situation could prevail under heavily loaded driving conditions, for example, a vehicle pulling a trailer uphill. The sampling technique for the vehicle tests was similar to the method used in the laboratory; that is, a measured volume of the tail pipe exhaust was passed through the KOH solution and titrated.

In the normal driving mode, there was no detectable HCN in the vehicle tail pipe emissions. When the car was driven under worst-case conditions, the vehicle exhaust contained 0.5 ppm of HCN, which is the approximate limit of detectability of HCN. These values from the vehicle tests are consistent with the laboratory study indicating a relatively small amount of HCN formed in the routine operation of the dual-bed catalyst system. We did not monitor the HCN concentration of the engine output during the vehicle tests. However, low concentrations of HCN (~ 1 ppm) have been detected in the exhaust of noncatalyst vehicles (*4*).

Thus the ability of an automotive catalytic converter to form HCN is strongly influenced by the chemistry of the exhaust gas. Significant amounts of HCN can be generated in moisture-free or low-moisture gas. When the gas composition is adjusted to approximate typical vehicle exhaust, laboratory data indicate that less than 1 ppm of HCN is formed. Actual vehicle tests have confirmed these laboratory data.

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25 November 1975

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