SCIENCE

24 October 1969

Vol. 166, No. 3904

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

How to put today's instrumentation to work for you.

Resolution so high we're finding new norms to test against

The Philips EM 300 Electron Microscope is capable of reaching a resolution of 2.3A under favorable circumstances.

Columbian Carbon Company for example, has been able to approach this limit in its studies of carbon black particles used in the manufacture of rubber. The photo on the right shows the basic lamellar structure with crystal planes 3.4A. apart.

Knowledge of lattice structures of various carbon blacks is extremely important because of the relationship of ultra structure to performance in rubber matrices.

The scientists at Columbian Carbon have been able to photograph the double sinuous form of the DNA molecule by supporting unstained and unshadowed strands between graphitized carbon black particles. The helical form is easier to see by viewing stereo image pairs.

In the thirteen years that Philips microscopes have been used at Columbian Carbon, more than one half million carbon black micrographs have been made.

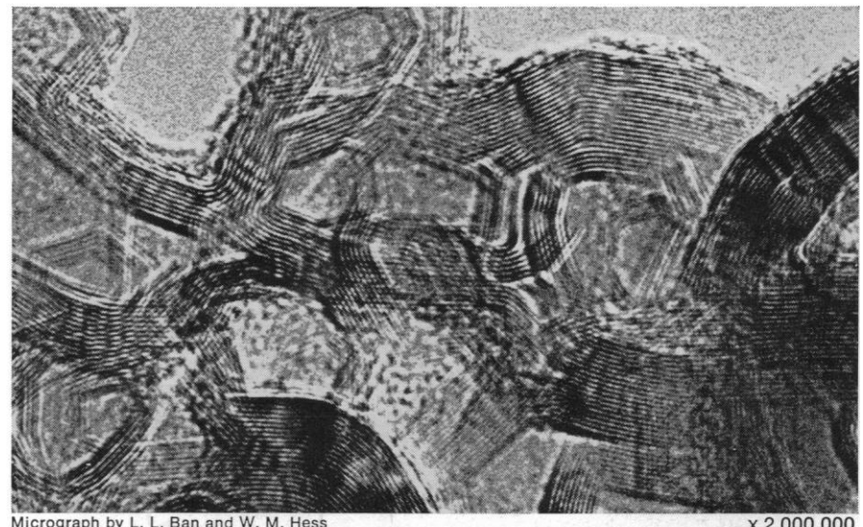
Using several Philips microscopes, Columbian Carbon now has a laboratory that operates at practically production speeds.

General Electric is another company extremely interested in the basic structure of crystalline materials. The micrograph on the right clearly shows the {111} lattice planes of a {112} slice of silicon. The spacing is 3.138A.

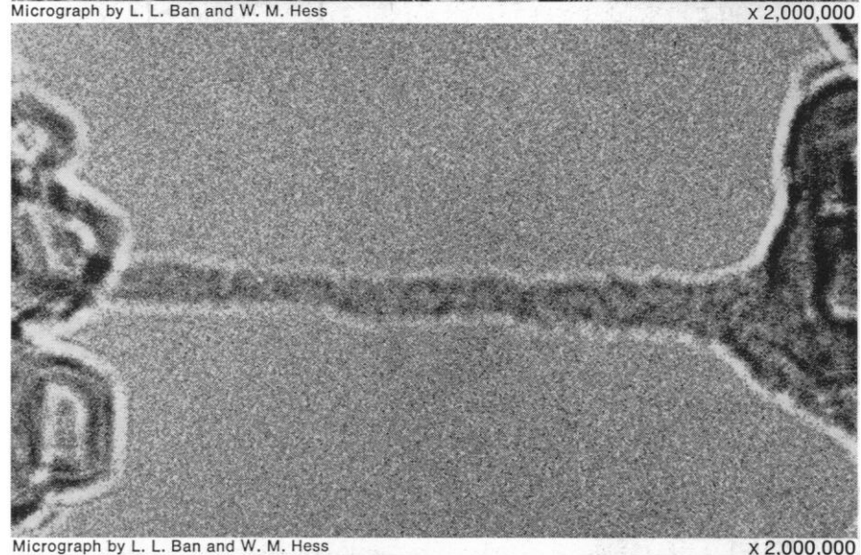
In addition to silicon crystal studies, General Electric researchers have obtained electron micrographs of germanium crystals with resolutions so fine they clearly show lattice defects only one atom wide.

If you have a resolution problem that's challenging, we'd like to hear from you.

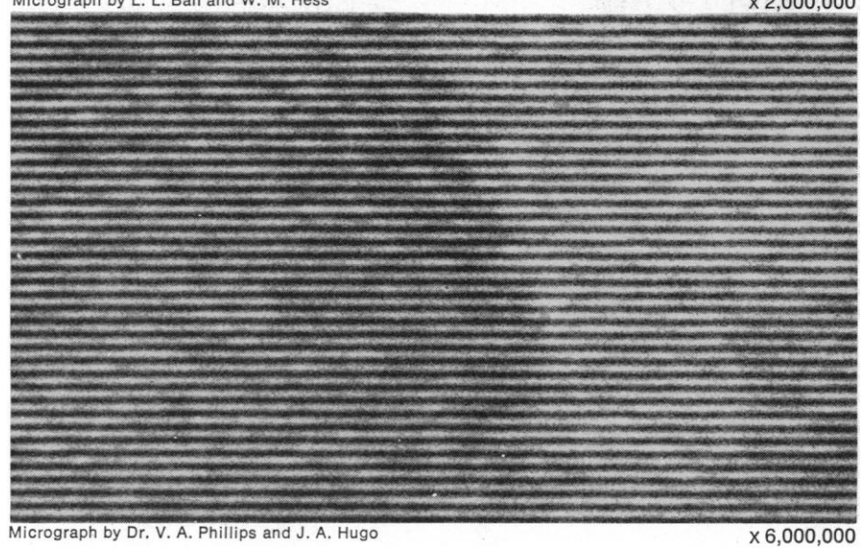
For more information, circle #1.



Micrograph by L. L. Ban and W. M. Hess x 2,000,000



Micrograph by L. L. Ban and W. M. Hess x 2,000,000



Micrograph by Dr. V. A. Phillips and J. A. Hugo x 6,000,000

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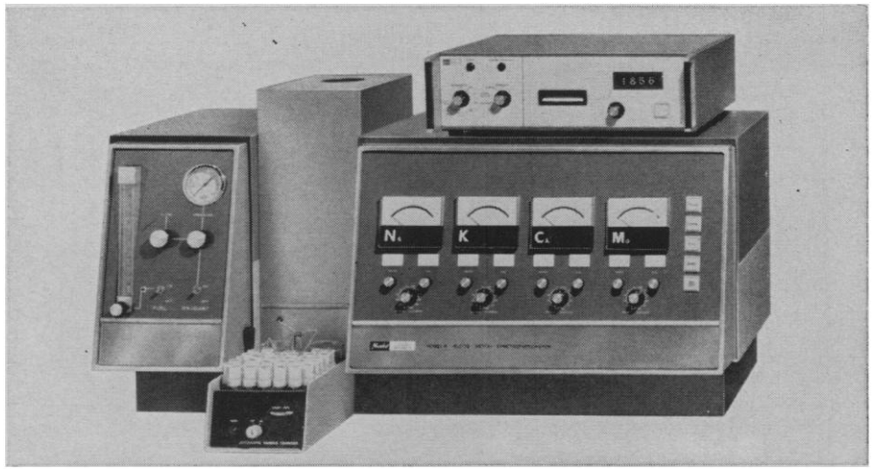
Simultaneous flame emission/atomic absorption analysis of a single blood sample for Na, K, Ca and Mg.



The Model 4 Blood Serum Spectrophotometer simplifies the approach to blood serum and biological fluid analysis by combining Flame Emission and Atomic Absorption techniques to allow simultaneous 4-element analysis.

Simply dilute a 0.1 ml blood serum with deionized water. Aspirate and, within 16 seconds, the automated Model 4 will produce a direct concentration digital printout for Na, K, Ca and Mg with sample identification.

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Circle #2.

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The SP 90 Atomic Absorption/ Flame Emission Spectrophotometer was designed to provide the chemist rapid, accurate and economical analysis of metals in solution.

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Circle #4.

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We wonder why people continue to debate the merits of one over the other. We make both because each has its own advantages.

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24 October 1969
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SCIENCE

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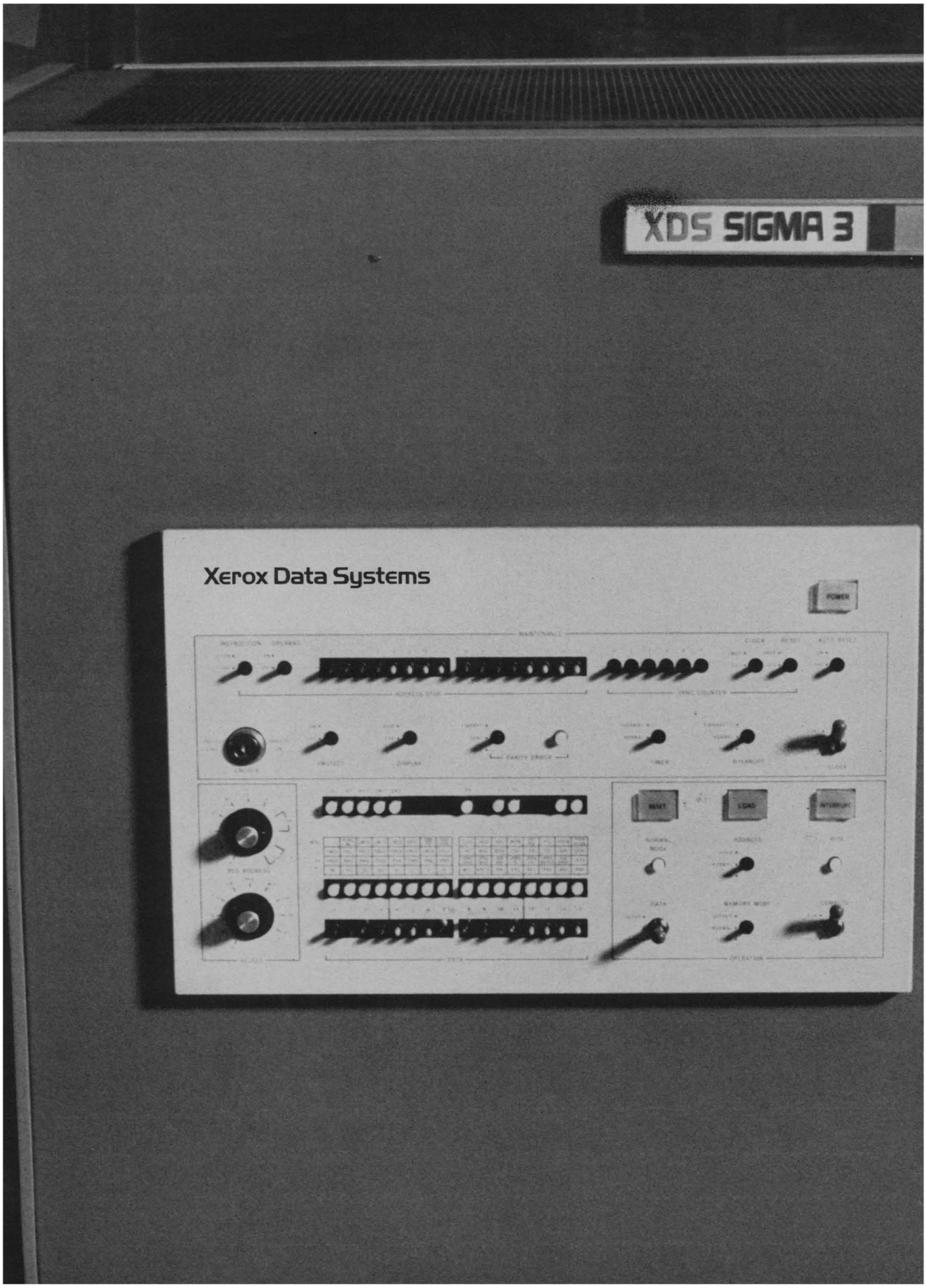
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

COVER

Basalt lava cascades from the active lava lake in Halemaumau crater during the 1967–68 eruption of Kilauea Volcano, Hawaii. See page 459. [Richard S. Fiske, U.S. Geological Survey]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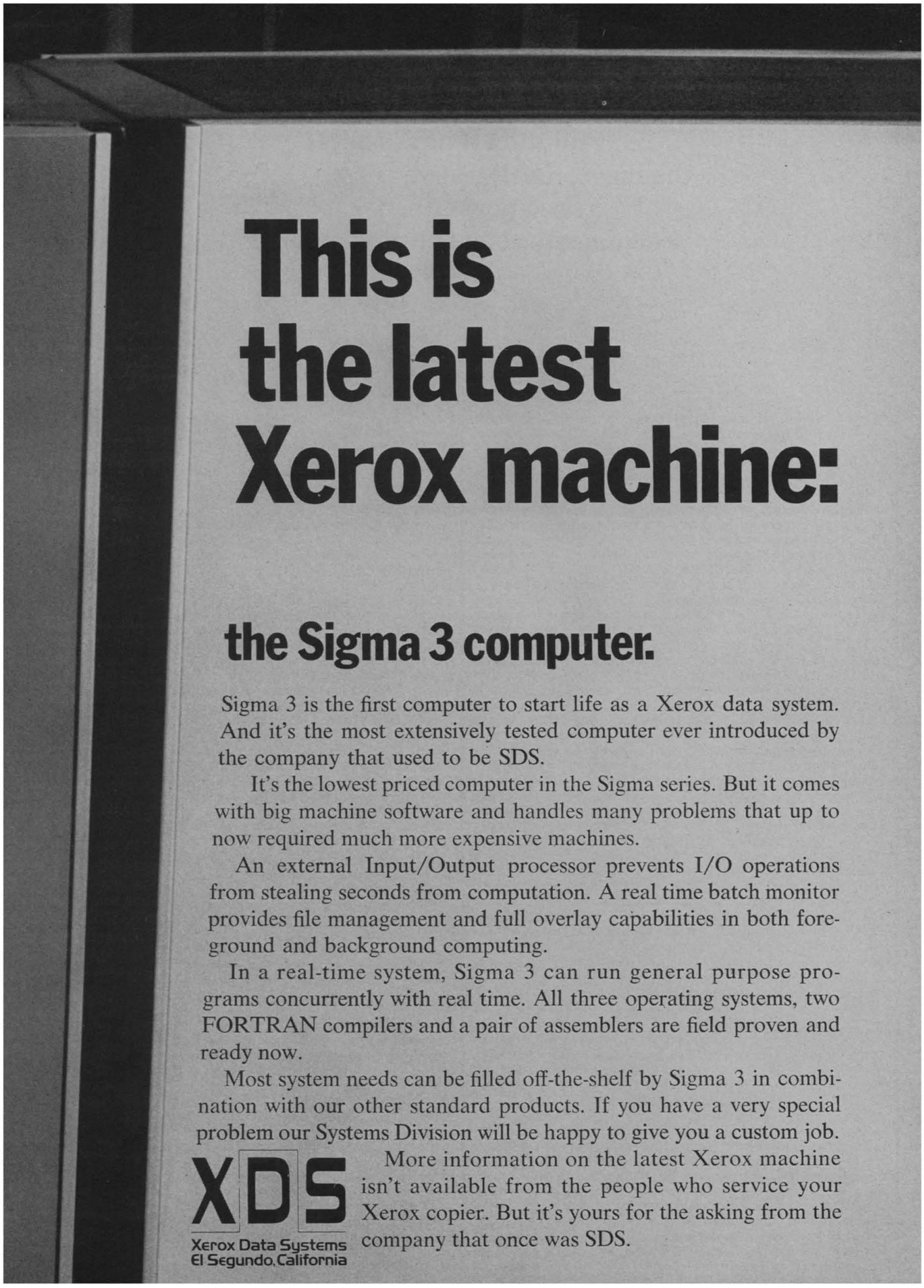
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Pollution that assaults the lungs, the digestive tract, the ear ...and how effective instruments can lead to abatement

The Lungs

Until very recently, Molecular Rotational Resonance (MRR) Spectroscopy often seemed like a brilliant scientific breakthrough destined to remain an ivory tower curiosity for lack of a practical application in the real world of quantitative analysis.

In its pristine form, MRR allowed the scientist to look into molecular structure by measuring changes in the absorption of microwave energy which result from transitions between rotational energy levels in a polar molecule. Because differences exist in the composition or geometry of individual molecular species, there is a characteristic MRR spectrum for each molecule. Absorption peaks are unique for each molecule and MRR readily differentiates between them, even in a complex mixture, because of its inherent specificity. In the usual case, measuring the frequency of a single absorption line completely identifies the molecule.

MRR has recently been shown to be a practical quantitative tool too. In a paper published in the *Journal of Chemical Physics* (46, 3698, 1967) the response of the HP 8400B MRR Spectrometer was shown to be linear with concentration from the lowest detectable limit to 100%. More recent work with common air pollutants (SO_2, NO_2, hydrocarbons) has demonstrated that MRR gives a quantitative response for each gas, even in the complex mixtures that are commonly associated with air pollution samples. The actual sensitivity limit for SO_2 has been determined at 3.5 nanograms without using concentration techniques (... this corresponds to a concentration of 11.6 ppb in a one liter sample). To further enhance its usefulness in the quantitative analysis of air pollutants, most MRR experiments are carried out at low pressures—typically 10-15 μ Hg—a condition that greatly reduces the rate at which the pollutants react with each other.

Precisely where the MRR Spectrometer fits into the pattern of analytical chemistry is still being studied. Based on the work reported above, it certainly should be considered for air pollution analysis, especially for calibrating on-site air pollution monitors. Results of experimental work in air pollution and other significant analyses with the MRR Spectrometer are published regularly in *Molecules and Microwaves*, a copy of which awaits your request.

The Digestive Tract

In the days before Rachel Carson's *Silent Spring*, the only popular connection between pesticides and the human digestive tract was benign: one was reassured that large parts of the world would be hungry, even suffer famine, except for the beneficial effect of pesticides on agricultural production. Nowadays, it's more common to hear warnings from respected scientific sources that pesticides constitute a real and present danger to life on this planet because they are ingested as residues in the food we eat and the liquids we drink.

These are not mutually contradictory arguments so much as they are accurate descriptions of both sides of the split personality of pesticides. The only conceivable solution to this very human dilemma is better control of the use of pesticides, and more careful analysis of pesticide residues in foodstuffs.

Enter the gas chromatograph (GC). While the men engaged in pesticide detection are many and far-flung, instrumentation for this sensitive work falls almost solely on the GC. On this basis, Hewlett-Packard has directed much research effort towards perfecting both instrumentation and technique. Although pesticide detection is still most often recorded in the nanogram range, an HP GC—more than four years ago—separated a laboratory pesticide sample at the picogram level. Most of this chemical detective work is being performed on the HP Model 402 High-Efficiency GC—an instrument perfected especially for this and other biochemical research. HP's pesticide analysts prefer to use this instrument equipped with an electron capture type of detector. The latter employs a radioactive tritium source to produce electrons whose capture by the pesticide molecules is a direct measure of their presence. Recently, HP chemist-designers have perfected a new electron capture detector that employs a radioactive Ni^{63} source that is more stable at higher temperatures thereby holding out a promise of more searching pesticide detection than the older tritium type can accomplish.

Sometimes the inherent difficulty of pesticide analysis is resolved by improvements in technique rather than hardware. HP chemists have developed special techniques for the analysis of pesticide residues in many foodstuffs, and sample extraction techniques for the analysis of bovine and human milk.

If you'd care to pursue this subject in more depth, write for Applications Lab Report 1003, yours on request.

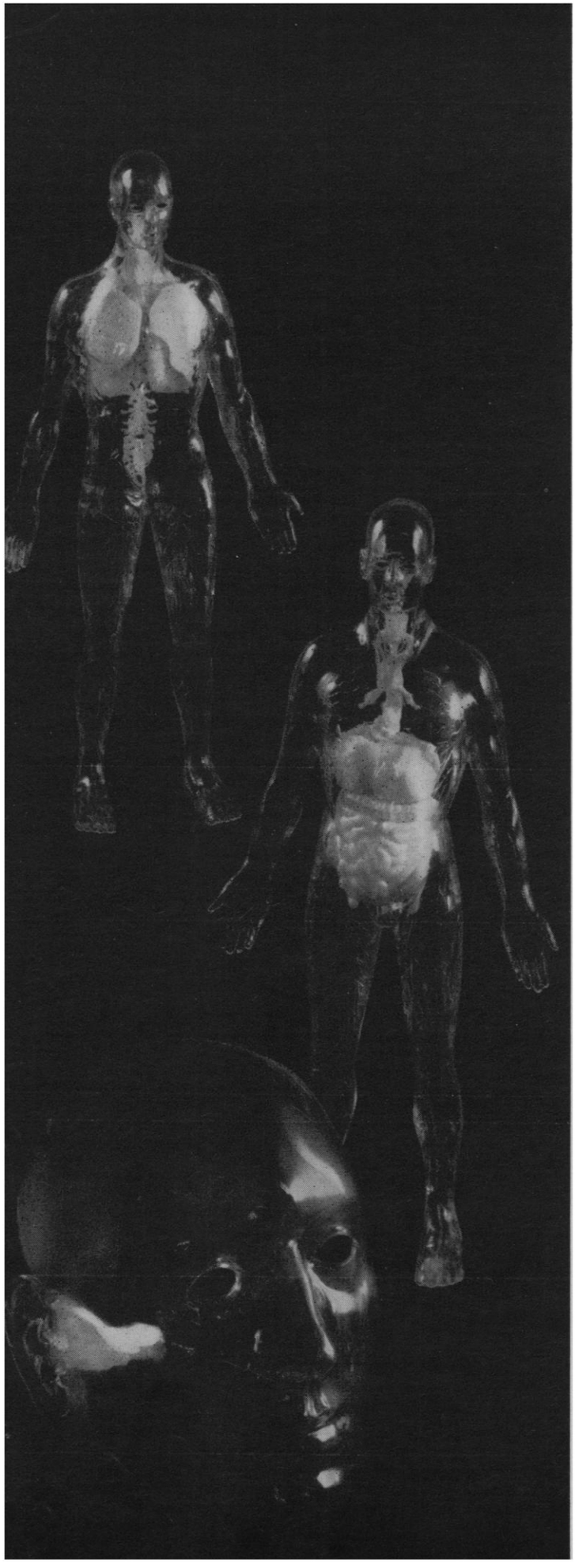
The Ear

Well played by a fine orchestra, Brahms can only be described as beautiful. But reproduced too loud on a cheap phonograph, it's noise. An increasingly widespread and serious form of pollution, noise can make us uncomfortable; prolonged loud noise damages hearing; very loud noises can cause pain, psychosis and even death.

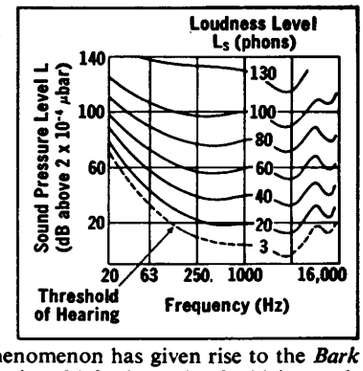
Obviously the time has come to control this form of 20th century environmental pollution. When HP scientists turned their talents to noise measurement, they ran into a very unusual problem. Objectively sound is simply a matter of rapidly changing air pressure, easy to measure with traditional sound level meters. But noise is really not an objective phenomenon: what the ear hears is a subjective sensation of loudness involving complicated physiological and psychological mechanisms.

For an instrument to measure sound as the ear hears it, it must imitate the unique properties of the ear. Take loudness level which is traditionally measured in *phons*. Although the logarithmic phon scale covers the large dynamic range of the ear—120 dB—it does not fit a subjective loudness scale. The trouble is that a noise that sounds twice as loud as another does not measure double the number of phons. So a subjective measure of loudness was developed by international agreement in which the unit is a *sone* and whose scale corresponds closely to the subjective sensation of loudness. For example, the comparison between a jet takeoff and a quiet conversation is 3:1 in phons (120 vs. 40) ... and a much more realistic 60:1 in sones (256 vs. 4).

Neither is the frequency response of the human ear a straightforward thing: the ear responds differently to sounds of different



frequencies and loudness levels. Although there is a small variation from person to person, normal ears agree within a few dB with the plot reproduced here (ISO Recommendation 226).



An even more significant peculiarity of the ear is its response to the pitch and bandwidth of a noise. Broadband sounds, like those of jet aircraft, seem much louder than narrowband noise of the same sound pressure level. Thus accurate loudness measurements can be made only by taking into account the spectral distribution of the sound and relating it to empirically determined critical bandwidths. This phenomenon has given rise to the *Bark* scale: the audio range comprises 24 Bark, each of which equals the ear's critical bandwidth at a given center frequency.

Probably the most significant difference between objective and subjective measure of loudness occurs when two sounds are presented to the ear simultaneously. If the two sounds are widely separated in frequency, their partial loudnesses simply add to form the total loudness. But if they are not separated by a critical bandwidth, one sound masks the other: the closer together, the greater the influence. The noise analyst expresses this characteristic quantitatively in terms of *loudness density*, in sones/Bark.

The HP 8051A Loudness Analyzer is, in effect, a calibrated electronic ear that takes all of these subjective reactions of the human ear into consideration in measuring loudness based on ISO Recommendation 532 (Zwicker's Method). It listens to sound through a calibrated microphone or tape recorder, automatically produces a continuous spectral analysis and displays it as a plot of loudness density vs. subjective pitch. The instrument also computes and displays the total loudness of the sound, that is the integral of the Zwicker diagram.

The instrument is a great help in noise abatement studies because it shows how noise reduction techniques can be applied most effectively. Its spectral analysis points the finger at the most obvious sound-producing component, suggests what kind of sound-absorbing material may be needed, offers quick *before* and *after* comparisons of noise abatement programs.

A much more complex and versatile instrument for audio spectrum analysis, the recently announced HP 80501A Audio Data Processor combines the equivalent of a Loudness Analyzer with a powerful HP 2115A Digital Computer. The 80501A measures loudness with Kryter, Stevens, TALARM, SAE or dB weightings depending on the choice of standard computer programs. Results are available immediately: for example, the 80501A yields a complete analysis of aircraft noise while the plane is still overhead.

Our new 116-page Acoustics Handbook does justice to this rather complex subject. For your copy, write to Hewlett-Packard, 1505 Page Mill Road, Palo Alto, California 94304. In Europe: 1217 Meyrin-Geneva, Switzerland.

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ANALYTICAL INSTRUMENTS 00970

24 October 1969, Volume 166, Number 3904 **SCIENCE**

Law and Science

The Supreme Court of California last month reversed a conviction for abortion in a decision that will be closely studied by persons interested in abortion laws and that may have a larger import for invalidating other laws that were enacted under conditions quite different from those that now obtain.

In 1966 an unmarried young woman requested an abortion from a Los Angeles physician. He refused, but after a highly emotional scene in which she threatened to go to Tiajuana for a criminal abortion, he did give her the telephone number of an unlicensed physician whom he knew to be performing skilled and safe abortions. A police raid led to trials and convictions of both physicians. The Supreme Court of California has now reversed the conviction of the referring physician.

At the time of the abortion, California law prohibited efforts to procure the miscarriage of a woman "unless the same is necessary to preserve her life." The Court's decision centered on the difficulty of determining the meaning of these nine quoted words (which are identical with or similar to words in the laws of many states), and on the difference between conditions in 1850 when the law was enacted and in 1966 when the abortion was performed.

In 1850, the Court noted, any abortion was extremely dangerous. Now, in contrast, "although criminal abortions [such as the woman threatened to have performed] are the most common single cause of maternal deaths in California," it is "safer for a woman to have a hospital therapeutic abortion during the first trimester than to bear a child." The conclusion was reached that, although the validity of the statute when enacted could be assumed, advances in medical skill and knowledge had made it constitutionally invalid now.

Moreover, the Court concluded that the quoted words were not susceptible of any interpretation that provided satisfactory guidance to a conscientious physician; that the law delegated responsibility to the physician but biased his decision, for any abortion always put him in jeopardy while the contrary decision never did; and that this delegation to a directly interested party violated the Fourteenth Amendment.

Since the Brandeis Brief of 1908 (in Muller *vs.* Oregon), the accumulation of new knowledge has sometimes been used to overthrow previous statutes or decisions, most notably in the Supreme Court's 1954 decision outlawing segregated schools. Although there is no novelty in the idea that new conditions may call for new laws, this decision nevertheless provides another reminder of the Supreme Court of the United States' 1898 statement that "the law is to a certain extent a progressive science," and calls attention to other situations in which advancing knowledge will have to be reflected in legal changes. The ability to artificially continue respiration and circulation after all signs of life in the brain have disappeared raises problems concerning the legal definition of death and concerning conditions under which organ transplants may be permitted. Organ transplants and their substitutes, such as the artificial kidney, pose questions of entitlement that were meaningless a few years ago. The prevalence of criminal use of guns (which may help provide organs for transplant) casts doubt on the wisdom of retaining the Second Amendment's declaration that the right "to keep and bear arms shall not be infringed." There is a whole web of issues on which advancing medical, technological, sociological, or psychological knowledge does, should, or perhaps will argue for legal change. The California Supreme Court has shown a judicial willingness to listen to the scientific evidence.—DAEL WOLFLE

AAAS SYMPOSIUM VOLUMES

Biology of the Mouth • Folk Song Style and Culture

Biology of the Mouth

Editor: Philip Person, Chief, Special Research Laboratory for Oral Tissue Metabolism, Veterans Administration Hospital, Brooklyn.

320 pp., electron micrographs and other illustrations, bibliog., index, 1968.

Price: $10.00. AAAS members' cash orders: $8.75.

A collection of comprehensive, multidisciplinary articles dealing with problems of the biology of the mouth and of oral disease and also the borderlands where fundamental approaches and investigations in physics and chemistry relate to, and can be brought to bear on, such problems. Among the disciplines represented are comparative anatomy and histology (light and electron microscopy), comparative molecular biochemistry, anthropology, paleontology, neuroanatomy and neurophysiology, zoology, botany, solid-state physics, and chemical physics. An attempt is made to integrate these varied contributions, to provide a broad perspective in which important mutual interests are identified and explored. This perspective includes the classical disciplines of Darwinian biology and the more recent disciplines of molecular and quantum biology, as well as their relationships to diseases of the mouth and oral structures. A feature of the volume is a highly original and significant contribution by Professor J. Z. Young dealing with the influence of the mouth upon the evolution of the brain.

Contents

Foreword: Place of Dentistry in Science.

Biology of Oral Tissues and Oral Disease: Darwin and Quantum.

Influence of the Mouth on the Evolution of the Brain.

Bone, Dentin, and Enamel and the Evolution of Vertebrates.

Tooth and Jaw in the Assessment of the Origins of Man.

Cleaning Symbiosis and Oral Grooming on the Coral Reef.

Lactoperoxidase, the Peroxidase in the Salivary Gland.

Biochemical Processes in Macromolecular Environments: Plant Cell-Wall Matrix in Lignin Polymer Foundation.

A Physicist Looks at Biology.

Role of Water in Some Biophysical Properties of Skeletal Tissues.

Biological Significance of Water Structure.

Water and Electrolyte Balance in Cells and Tissues.

Molecular Evolution of Connective Tissue.

Comparative Ultrastructure and Organization of Inorganic Crystals and Organic Matrices of Mineralized Tissues.

Folk Song Style and Culture

A Report on Cantometrics by the Staff of the Cantometrics Project of Columbia University, Alan Lomax, Project Director.

384 pp., 80 illus., 87 tables, bibliog., index, 1968.

Price: $16.75. AAAS members' cash orders: $14.50.

Working with a large sample of recorded songs and filmed dances from all culture areas of the world, the Cantometrics Project has discovered some of the ways in which song and dance style vary by culture area. Strong statistical relationships have been established between a set of basic factors of social and economic structure and performance style. The book reports on an imaginative yet rigorous exploration of the paralinguistic and parakinesic realms and a thoroughgoing test of the hypothesis that factors of cultural style are primary forces in shaping all human behavior. Performance style here becomes a psychocultural indicator, and, for the first time, the social and cultural import of the expressive act is firmly established.

Contents

The Stylistic Method; The Cantometrics Experiment; The Cantometric Coding Book; The World Song Style Map.

Consensus on Cantometric Parameters: A. Consensus Testing; B. The Paralinguistic Framework.

Song as a Measure of Culture; Social Solidarity; Self-Assertion, Sex Role and Vocal Rasp; Effects of Infantile Stimulation on Musical Behavior.

Dance Style and Culture; Choreometric Profiles; The Choreometric Coding Book; Folk Song Texts as Culture Indicators; Cantometrics in Retrospect.

Appendixes: Data Systems and Programming; Statistical Notes; Summodal Profiles for Nine World Song Style Regions.

Bibliography. Folk Song Text Sources. Film Sources.

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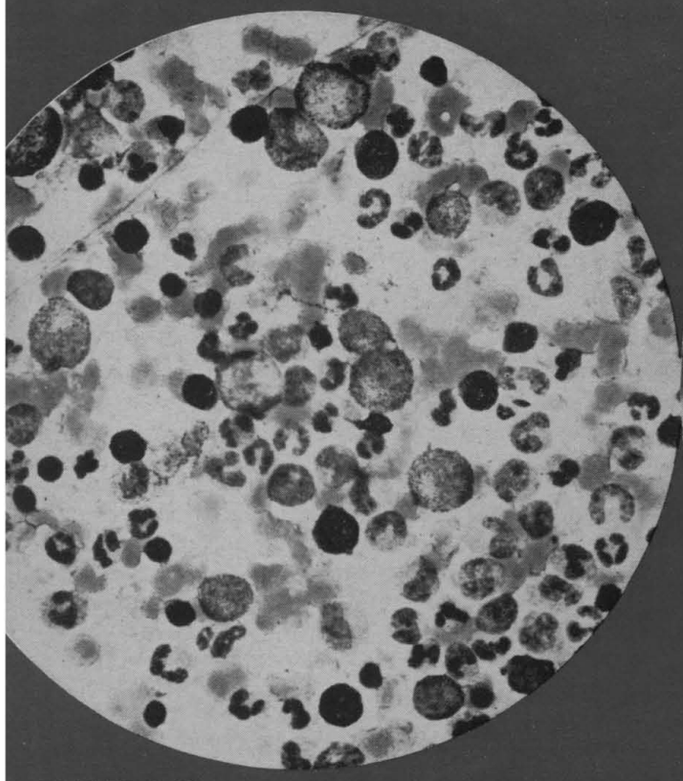

OURS Bone marrow. Taken with a 100X objective and 10X wide field eyepiece on a Bausch & Lomb EXTRA VALUE DynaZoom Full Image Flat Field Microscope.

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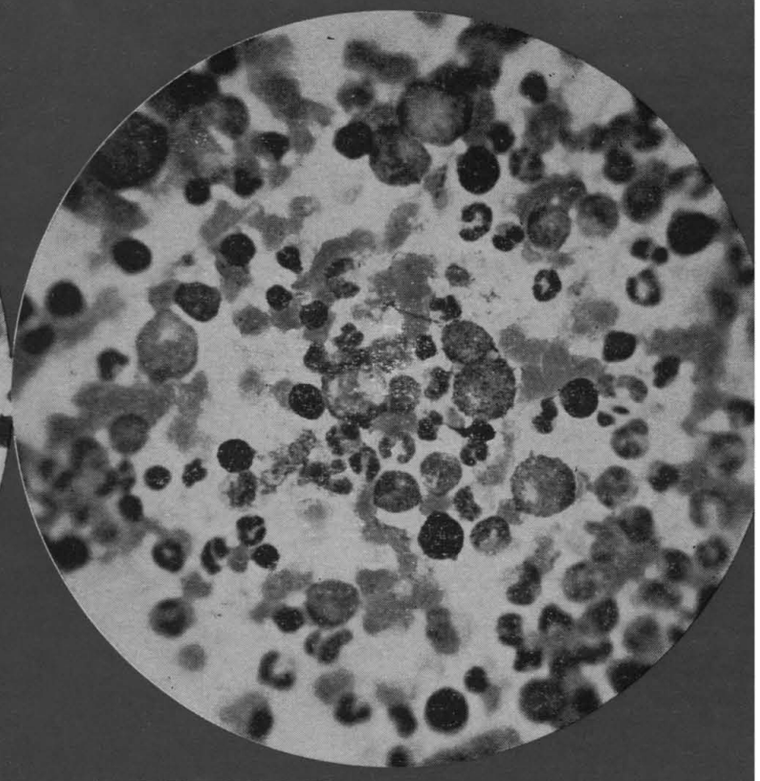
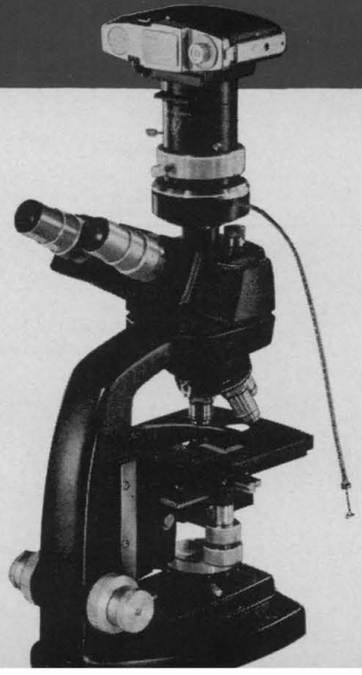


THEIRS Bone marrow. Taken with a 100X objective and 10X wide field eyepiece on a competitor's top-of-the-line model.

Bausch & Lomb Flat Field Microscope performance cannot be matched for anywhere near its competitive cost.

DynaZoom, Reg. T.M., Bausch & Lomb



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