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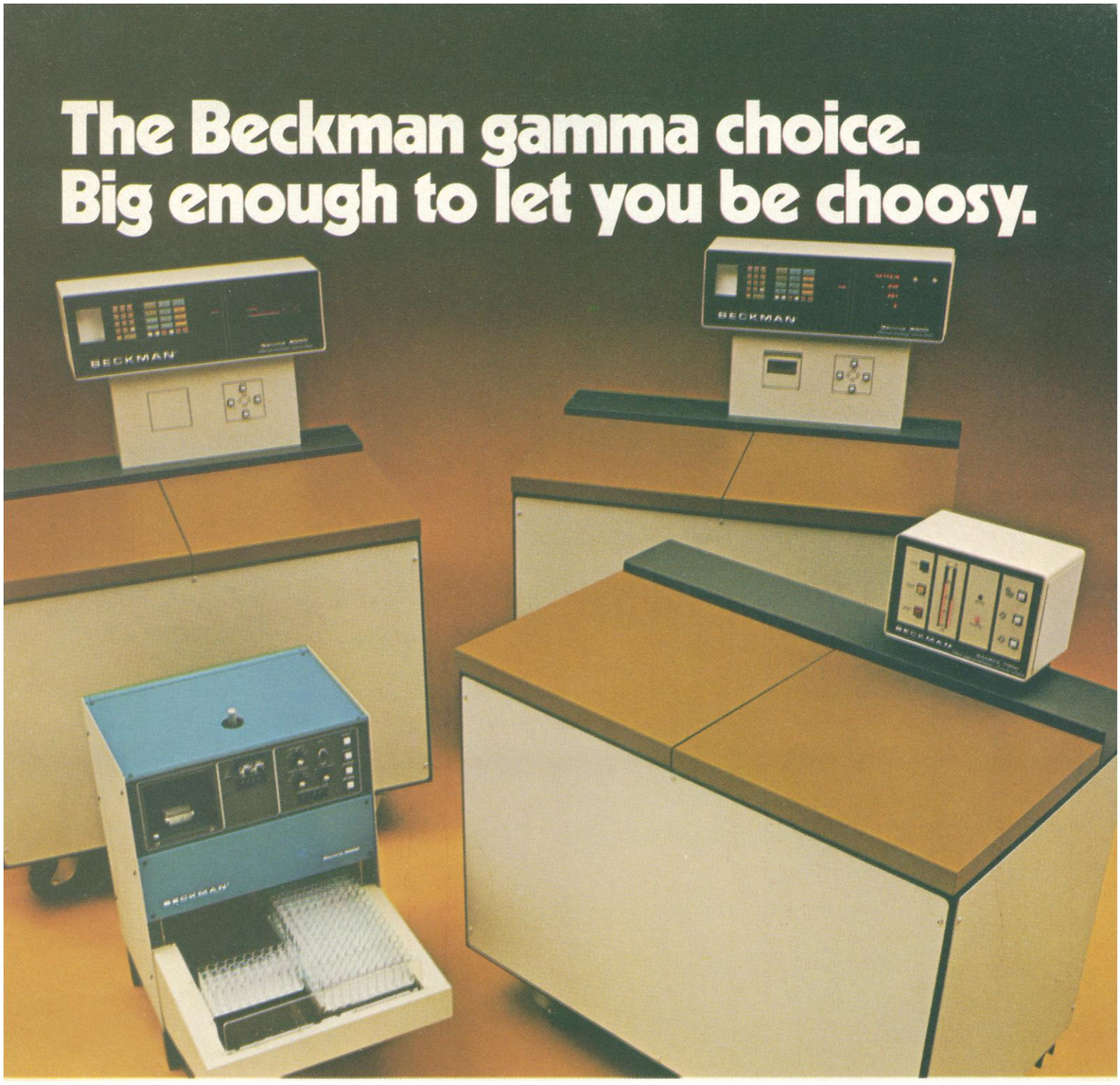

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COVER

Sebastolobus alascanus. The muscle-type lactate dehydrogenase of this scorpaenid fish is markedly more sensitive to moderate hydrostatic pressures than is the homologous enzyme of its deeper-living congener, *Sebastolobus altivelis*. Such pressure-adaptive differences may be important in establishing species depth zonation patterns in the sea. See page 255. [Thomas W. Okita, Scripps Institution of Oceanography, University of California, San Diego]

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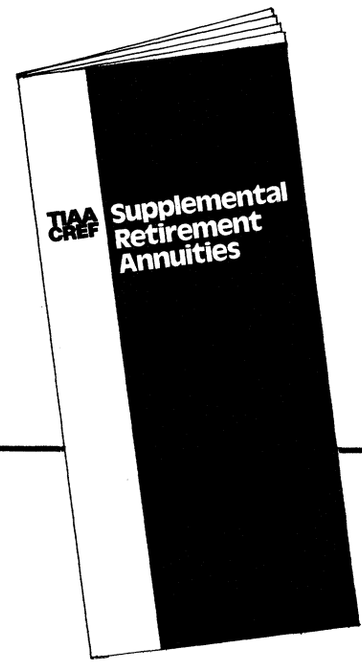

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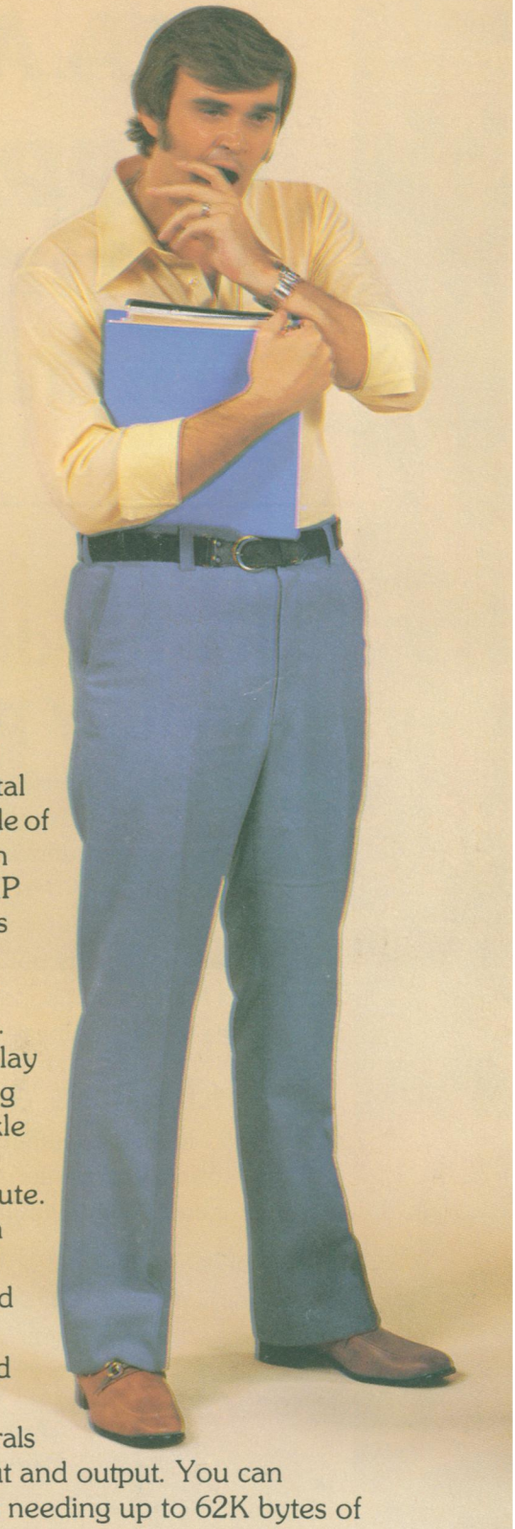

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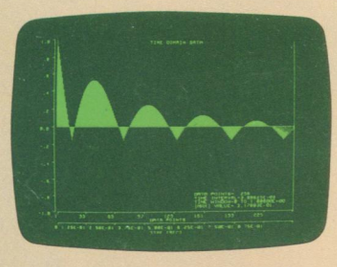

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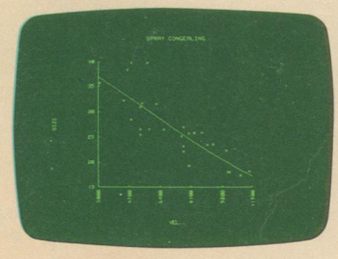

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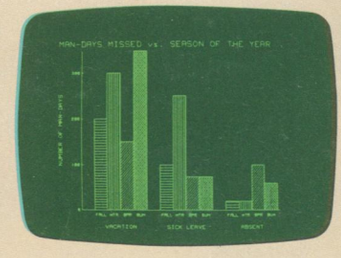

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afflicting these two organs. Hepatic and splenic disorders are by no means few, and some of the tropical diseases affecting millions in the developing world are good examples. Research in this country (*11*) has shown that treatment of experimental visceral leismaniasis with small amounts of liposome-entrapped antimonial drugs is as effective in killing the parasites in the liver as are much larger doses of free drugs. Success in this area of medicine would not only resolve problems of toxicity that prevent aggressive chemotherapy, it would also make therapy economically realistic for the countries involved.

Routes other than the intravenous have also been used for the administration of liposomes. Work at this laboratory (*12*) and elsewhere in England (*13*) suggests that insulin-containing liposomes given intragastrically can transport the hormone into the circulation and reduce blood glucose levels in diabetic rats. We have found that the effect is more pronounced when liposomes are made of certain semisynthetic phospholipids which, at the body temperature, are more resistant to pancreatic phospholipases or to detergents. Again, the implications for success in treating diabetic patients orally cannot be overemphasized. However, there are difficulties to overcome, among them, improving the absorption of liposomal insulin by the gut.

Local injection of liposomes as a means of drug administration is likely to be an early application mainly because of the avoidance of complications arising from intravenous use. Work at this laboratory (*14*) suggests that the need for a biocompatible immunological adjuvant that will make vaccination safer, more effective, and cheaper, may be satisfied by liposomes. Thus, immune response to liposome-entrapped bacterial and viral antigens administered intramuscularly was found to be much greater than when free antigens were used. Yet another possible means of local drug release is being investigated by workers in England who have shown (*15*) that specially tailored steroids anchored onto the liposomal membrane can, upon intraarticular injection into rabbits with experimental arthritis, decrease the temperature and the size of the joint to a much greater extent than can similar amounts of conventional steroids.

So far, experiments here and in Germany and experience with routine intravenous feeding with phospholipids suggest that liposomes of certain lipid compositions are almost certain to be safe (*16*). Indeed, in situations where some exploratory work in humans is

deemed essential (for example, liposome distribution in cancer patients when the anatomical and physiological circumstances of tumors cannot be duplicated in animals), their use should not be discouraged. There is, however, some concern with regard to the toxicity that drug-containing liposomes may induce as a result of an altered drug distribution, of an unsuspected novel way of drug action, or even because of the patient's reaction to the carrier. For instance, were one to administer (bovine or porcine) insulin-containing liposomes orally to normal volunteers, there could be a manifestation of the adjuvant property of the carrier with formed antibodies neutralizing the cross-reacting human insulin.

Progress in modifying cell structure and behavior by the use of liposomes in vitro has been, thanks to the obliging properties of the system, remarkable. It may be that the complexities of the living animal and ethical and practical difficulties in dealing with human subjects have delayed similar progress in medicine. This has caused some confusion as to the potential value of the carrier in helping to alleviate disease. But the need for controlled drug delivery is patently obvious; on this basis, liposomes (or their more sophisticated versions) along with other carriers are likely to play a significant role.

GREGORY GREGORIADIS
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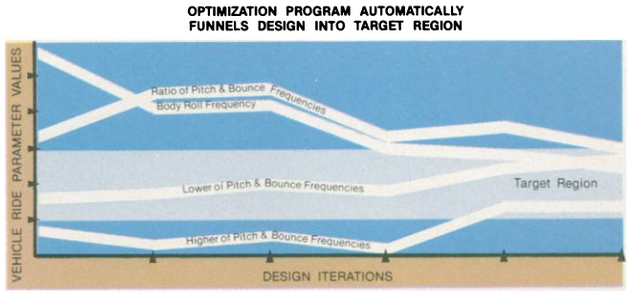

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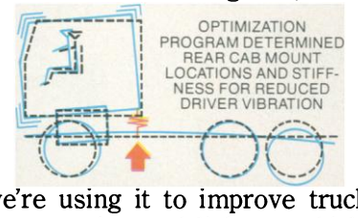

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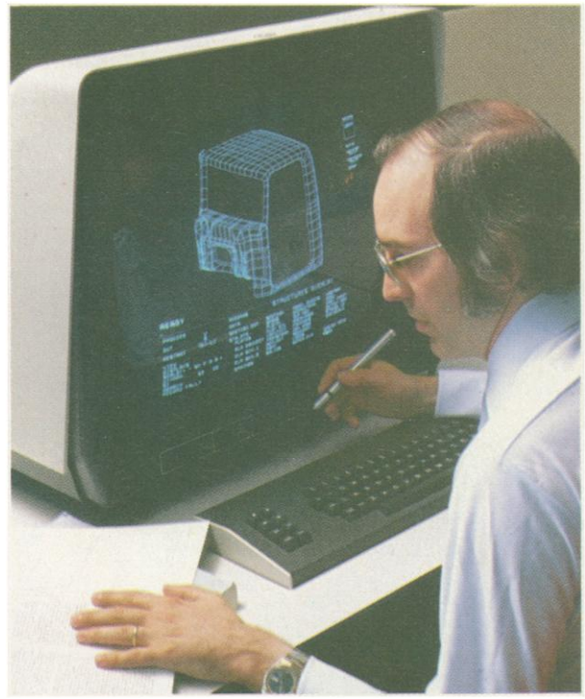

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21 July 1978, Volume 201, Number 4352 **SCIENCE**

The Golden Age of the Geoscientist

Exploration for energy and minerals has followed a cyclic pattern of feast or famine. Post–World War II exploration programs led to a rapid expansion of undergraduate and graduate training in the geosciences, and a large cadre of professional geoscientists subsequently entered industry. But in the mid-1950's, the situation abruptly changed. In the spring of 1956, a colleague in a southwestern university confided to me that, although his department was training 300 undergraduate majors, only two microscopes were available to students. In the fall of 1957, I asked this same colleague how many undergraduate majors had enrolled in his department. His answer: two. What was the reason for such a drastic decline in enrollment? In early 1957, famine had replaced feast in the exploration business. Companies closed exploration offices and laid off geoscientists.

In the 1960's, the employment pendulum swung less dramatically, but in 1973 we entered a new age: exploration efforts in the United States became extremely active, and demand for geoscientists and petroleum engineers climbed steeply.

Ordinarily, a master's degree is considered essential by industry, except for those with bachelor's degrees who are well trained in mathematics and physics and entered the field of geophysics. However, with the steeply increasing demand, even poor students with only a bachelor's degree have found first-rate employment. Good students with master's degrees, especially women and members of minority groups, have special opportunities. They are likely to receive more than five job offers from major oil corporations at salaries ranging from $17,000 to $21,000 per year.

With this frenetic hiring one would think that these corporations could quietly put their geoscientists to work in a creative effort to find more reserves. But the truth is that most geoscientists on the staff of major companies are inexperienced. In one major corporation I know of, almost 80 percent of the geoscientists have less than 2 years of experience. Small exploration companies, known as independents, woo geoscientists away from the major corporations with excellent salaries, bonuses, and fringe benefits. Body snatching is hardly new in the exploration business, but in the past young scientists needed 5 years of experience before they became attractive to independents. Today that period is commonly only $1\frac{1}{2}$ years. Thus the major corporations have become the training ground for the independents. Among my students, it is not unusual for 25- to 27-year-olds with recent master's degrees to earn salaries of $30,000 per year plus a free car, gas, repairs, and insurance. No wonder this is considered the golden age of the geoscientist.

The needs for graduate training in the earth sciences, however, are selective. The fields most required include geophysics, stratigraphy, sedimentology, and tectonics. Basic supporting training in physics, chemistry, and mathematics is important. Departments that are strong in the four fields of geology named above have bulging graduate enrollments. Ph.D. training is commonly considered a luxury today because industry wants and needs trained scientists *now*.

In other countries geoscience is still sleepy, but activities are increasing. In the United Kingdom and Western Europe, the fate of trained geoscientists used to be emigration. Today the job market is expanding, and geoscientists may find employment at home. A new breed of geoscientist is the government-company scientist of OPEC countries. In these countries, and in those aspiring to OPEC stature, new opportunities in geoscience are opening up.

Geoscientists will be in demand for the foreseeable future as the world seeks to meet its needs for energy and minerals. But the lessons of the past should not be forgotten. The feast of today may once again be followed by famine.—GERALD M. FRIEDMAN, *Chairman, Section E, AAAS, and Department of Geology, Rensselaer Polytechnic Institute, Troy, New York 12181*

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