# COVER SHEET
# FOR TRIP REPORTS SUBMITTED TO THE OFFICE OF ENERGY RESEARCH

**Destination(s) and Dates for Which Trip Report Being Submitted:** Japan and U.S.S.R. - 9/1-20/89

**Name of Traveler:** Elias Greenbaum

**Joint Trip Report** ☐ Yes
☒ No

**If so, Name of Other Traveler(s):** _____

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# ORNL

# FOREIGN TRIP REPORT

ORNL/FTR-3388

DATE: September 29, 1989

SUBJECT: Report of Foreign Travel of Elias Greenbaum, Development Staff Member II, Chemical Technology Division

TO: Alvin W. Trivelpiece

FROM: Elias Greenbaum

PURPOSE: To present invited lectures at the First International Conference on Marine Biotechnology, Tokyo, Japan, and the Second International Conference on Molecular Electronics and Biocomputers, Moscow, U.S.S.R. Invited research seminars were also presented at the Tokyo Institute of Technology and Moscow State University.

SITES VISITED:

| | | |
|---|---|---|
| 9/3-7/89 | First International Conference on Marine Biotechnology, Tokyo, Japan | T. Matsunaga, conference participants |
| 9/6/89 | Mitsubishi Heavy Industries, Tokyo, Japan | Y. Ikuta |
| 9/8/89 | Tokyo Institute of Technology, Tokyo, Japan | I. Okura |
| 9/11-16/89 | Second International Conference on Molecular Electronics and Biocomputers, Moscow, U.S.S.R. | Pavel I. Lazarev, conference participants |
| 9/12/89 | Moscow State University | V. Z. Paschenko |

ABSTRACT: The traveler was invited to present lectures on ORNL research in the physics and chemistry of photosynthesis and microalgal biotechnology at the First International Conference on Marine Biotechnology and the Second International Conference on Molecular Electronics and Biocomputers. In addition, professional colleagues in the Department of Bioengineering, Tokyo Institute of Technology, and the Department of Molecular Biology and Biological Physics, Moscow State University, invited him to present research seminars at their respective institutes. One afternoon was spent in the Tokyo offices of Mitsubishi Heavy Industries discussing the greenhouse effect, carbon dioxide reduction, possible global warming, and the production of nongreenhouse gas fuels.

# REPORT OF TRAVEL TO JAPAN AND U.S.S.R.

September 1-20, 1989
Elias Greenbaum

## Japan

The traveler was an invited speaker at the First International Marine Biotechnology Conference, September 4-6, 1989, Tokyo, Japan. He also presented a research seminar in the Department of Bioengineering, Tokyo Institute of Technology, and visited Mitsubishi Heavy Industries to learn of that company's interest and research programs in photosynthesis and biotechnology.

The First International Marine Biotechnology Conference was organized by the Japanese Society for Marine Biotechnology. It was sponsored by a broad spectrum of Japanese government offices, scientific societies, and private companies. Appendix D is a photocopy of the inside front cover of the book of abstracts which summarizes this support.

The keynote address was presented by Professor A. A. Benson of the Scripp's Institution of Oceanography. Professor Benson, a highly distinguished scientist, is the Benson of the Calvin-Benson cycle which traces the path of carbon in photosynthesis. Benson presented a very wide-ranging talk touching on the historical, fundamental, and applied aspects of marine science and technology. Each of these areas was illustrated by citing key individuals involved in major breakthroughs with a description of their work and its technological implications.

A second plenary lecture entitled "From Material Civilization to Life Centered World" was presented by Professor Itarie Wataube of Keio University. This philosophical lecture encompassed the concept of "matter → life → spirit." Professor Wataube concluded

that the future holds technological and ideological developments that would lead from material civilization to life-centered civilization.

Multiple parallel sessions were held during this conference. It was therefore not possible for the traveler to attend all of the sessions.

The traveler chaired the session on supporting technology in marine biotechnology research. This session included a broad spectrum of technological and engineering research performed by university and industrial research, both separately and collaboratively.

R. Narushi, Kansai Paint Company, presented a paper entitled "Influence of Structural and Thermodynamic Properties of Phase-Separated Films on Adsorption of Proteins and Marine Fouling." Narushi described a specific relation between the work of adhesion of the proteins and the interfacial energy of the surfaces in water. G. Uematsu, Tosok Corporation, presented a paper entitled "Microbial Production of Eicosapentanoic Acid." He described the isolation of a marine bacterium, *Shewanella putrefacieus* SCRC-2738, that was isolated from the intestine of a marine fish. This strain produced EPA at 20 to 40% of the total fatty acid in the bacterial cells. Professor K. Mori, Keio University, discussed "Applications of a Solar Light Collection and Distribution System in Marine Biotechnology." Professor Mori is well known to the traveler. He has previously presented a paper at the ORNL symposia series on biotechnology for fuels and chemicals.

K. Ohueada, Ocean Research Institute, University of Tokyo, described "A System for Sampling and Culturing Deep-Sea Microorganisms under Pressure." This paper was in the relatively new field of barobiology -- high-pressure biology. A system for the retrieval of deep-sea microorganisms under in situ pressure and subsequent culture without decompression was described.

S. Tsuchiya, Ishikawajima Harima Heavy Industries, described "Fish Shoal's Reaction Against a Laser Beam Screen." This presentation was part of a larger Japanese program on *The Study of New Sea Farming Technologies*. The key result of this presentation was that it is possible to develop a laser screen to alter fish behavior. S. Wouthuyzen, Seikai Regional Fisheries Research Laboratory, discussed monitoring surface chlorophyll a concentration, using remote sensing techniques, in Omura Bay. In this work, a series of measurements of total suspended solids and chlorophyll a concentration synchronized with the overpass of Landsat 5 or MOS-1 satellite systems was carried out in Omura Bay, northwest of Kyushu, Japan. M. Maeda, Ocean Research Institute, University of Tokyo, discussed bacteria as biocontrol agents in aquaculture. This presentation described bacteria which improved the growth of prawn and crab larvae. N. Nakamura, Tokyo University of Agriculture and Technology, described a method for the electrochemical sterilization of marine microorganisms. Nakamura demonstrated that *Vibrio alginolyticus* was sterilized when held at a potential of 0.8 V vs SCE for 10 min.

A session on atmospheric carbon dioxide and marine biotechnology was scheduled. Y. Sugimura, Meteorological Research Institute, presented an overview lecture of increasing carbon dioxide in the air and the oceanic carbon cycle. The "bottom line" of Sugimura's talk was that although there are many uncertainties, the oceans do not have sufficient buffering capacity against the increasing levels of carbon dioxide caused by burning fossil fuel. S. Miyachi, Institute of Applied Microbiology, University of Tokyo, presented a talk on carbon dioxide--concentrating mechanisms in microalgae and cyanobacteria. This talk focused on the fundamental research aspects of carbon dioxide reduction -- in particular, the movement of inorganic carbon across cell membranes and equilibration between carbon dioxide and bicarbonate.

M. Okazaki, Tokyo Gakugei University, and E. W. de Vrind-de Jong each presented lectures on plant systems that convert carbon to carbonate. For example, calcium carbonate formation by *Emiliana huxleyi* forms in open-structured skeletons, which has resulted in vast limestone deposits on the deep ocean floor. The deposits are important constituents of the buffer reservoirs for atmospheric carbon dioxide.

Other sessions of the conference included microorganisms (2); microalgae (3); fish, shellfish, and other animals (3); interfacial subjects; and supporting technology.

The traveler also presented a research seminar entitled "Photosynthesis and Biotechnology: Bioelectronic Devices and Energy Conversion Studies" at the Tokyo Institute of Technology. His host was Professor Ichiro Okura of the Bioengineering Department. The seminar was attended by graduate students and faculty.

The traveler also visited the Tokyo offices of Mitsubishi Heavy Industries for discussions on photosynthesis, carbon dioxide, and the global greenhouse effect. His host at Mitsubishi was Y. Ikuta.

## U.S.S.R.

The traveler was invited to participate in the Second International Conference on Molecular Electronics and Biocomputers. The conference organizer was Dr. Pavel I. Lazarev, Institute of Biological Physics, U.S.S.R. Academy of Sciences.

"Molecular electronics" is the term used to describe a broad spectrum of fundamental and applied research dealing with phenomena on a molecular level. The objective of this work is the development of devices based on molecular phenomena that could have technological applications. The simplest of these devices are chemical and biochemical transducers. In these devices, molecular components are used as the sensing elements to convert an input stimulus into an output signal. The output signal is usually

a voltage or current. "Biocomputer" was a term used by some of the conference participants to describe larger-scale integrated structures that may have computational capabilities. Some conference participants feel that the potential of biocomputers can exceed that of conventional computers.

The substantive aspects of the papers presented were composed of solid experimental research programs as well as speculative theoretical papers and mathematical modeling. The experimental work included research from both new and well-established fields such as scanning tunneling microscopy, Langmuir-Blodgett films, interfacial electron transfer reactions between biomolecules and electrodes, molecular spectroscopy and magnetism, and atomic force spectroscopy.

Professor H. Kuhn, Max Planck Institut für Biophysikalische Chemie, is a recognized authority on monolayer assemblies. He presented a talk entitled "Monolayer Assemblies in the Search for Ways to Build Supramolecular Machines." Professor Kuhn presented an overview talk illustrating recent developments in fabricating and manipulating complex monolayers. The objective of these fabrication techniques is the synthesis of sophisticated molecules or molecular complexes and/or the prefabrication of elements (such as vesicles stabilized by polymerization) that carry appropriate recognition and binding sites.

Professor J. M. Lehn, Université Louis Pasteur, discussed the possibilities of molecular recognition and information signal processing at the molecular level. Lehn's lecture touched on many of the frontier research topics in this field. Of special interest in this field is the possibility of designing devices by molecular self-assembling. Molecular self-assembling is the spontaneous generation of a desired molecular architecture from its components under a given set of conditions. One example of molecular self-assembling is the formation of double-stranded helicates that results from the spontaneous organization

of two linear polybipyridine ligands into an organic double helix by binding of specific metal ions. Lehn also discussed electro-active and iono-active devices and their role in carrying electric signals.

F. T. Hong, Wayne State University, presented a lecture on common design principles for photoactive transport and sensor proteins. Hong's talk was based on the fact that two different molecular chromophores exist in photoactive transport proteins (photosynthetic reaction centers) and photosensor proteins (visual pigment rhodopsin). He presented theoretical and experimental data based on early receptor potentials and mathematical modeling.

P. I. Lazarev, Institute of Biophysics, U.S.S.R. Academy of Sciences, presented a lecture on proteins of the electron transport chain as a prototype of monoelectronic materials. In this context, "monoelectronic" refers to single molecule/electron events (such as oxidation-reduction) in which one bit is coded by one electron. Lazarev pointed out that today's technology for cluster formation using conventional materials cannot achieve the required resolution to measure single electron events in single molecules. He concluded with the observation that biomolecules of the electron transport chain are the best possible potential current materials for monoelectronics.

L. M. Blinov, Institute of Crystallography, U.S.S.R. Academy of Sciences, presented a discussion on piezoelectric effects in aqueous lyotropic chiral mesophases and thermotropic liquid crystalline polymers. Various aspects of piezoelectricity were discussed, such as shear flow-induced and thermal ferroelectric phenomena. The key point of Blinov's presentation was that the materials that he is working with are of significant interest for the development of a new generation of pyro-, piezo-, and non-linear optical materials.

Yu M. Lvov, Institute of Crystallography, U.S.S.R. Academy of Sciences, presented a talk on the structural aspects of molecular Langmuir-Blodgett techniques. The key aspect of Lvov's work was the chemical treatment of homogeneous LB films, resulting in the formation of a new phase or super lattice in the host matrix. Using this technique with cadmium and lead stearates, interlayers of polycrystalline CdS and PbS (as demonstrated by small-angle x-ray scattering) were formed.

Atomic force microscopy is a new imaging tool for surfaces at ambient conditions under liquids or in vacuum. O. Marti, Quantum Electronics Institute, ETH, Switzerland, presented a discussion of this technique and demonstrated its use in imaging surfaces such as polymerized monolayers of n-(2-amino-ethyl)-10,12-tricosadiynamide, individual methyl groups of an amino acid crystal, and the silicon oxide. Marti feels that future applications of atomic force microscopy could include routine characterization of surfaces and monitoring of reactions of biomolecules on and with surfaces at molecular resolution.

The traveler was also invited to present a research seminar in the Department of Molecular Biological Physics, Moscow State University. He presented an overview of ORNL research in photosynthesis, photobiological energy conversion, and biomolecular electronics. His host was Professor V. Paschenko.

# APPENDIXES

## A. ITINERARY

| | |
|---|---|
| September 1-3, 1989 | Travel from Oak Ridge, Tennessee, to Tokyo, Japan |
| September 4-7, 1989 | First International Conference on Marine Biotechnology |
| September 6, 1989 | Mitsubishi Heavy Industries, Tokyo, Japan |
| September 8, 1989 | Department of Bioengineering, Tokyo Institute of Technology, Tokyo, Japan |
| September 10, 1989 | Travel from Tokyo, Japan, to Moscow, U.S.S.R. |
| September 11-16, 1989 | Second International Conference on Molecular Electronics and Biocomputers, Moscow, U.S.S.R. |
| September 12, 1989 | Department of Molecular Biology and Biological Physics, Moscow State University, Moscow, U.S.S.R. |
| September 17-20, 1989 | Travel from Moscow, U.S.S.R., to Oak Ridge, Tennessee |

## B. PERSONS CONTACTED

Japan

| | |
|---|---|
| Takayuki Arai | Shiseido Basic Research Laboratories<br>1050 Nippa-Cho, Kohoku-ku<br>Yokohama-Shi, Japan 223 |
| Yoshiharu Fukuju | Mitsui Engineering and Shipbuilding Co., Ltd.<br>1, Yawatakaigan-Dori<br>Ichihara-City<br>Chiba Prefecture, Japan |
| Hiroyuki Furuune | La Foret Engineering & Information Service, Co., Ltd.<br>Toranomon 2-7-8<br>Minato-ku, Tokyo 105, Japan |
| Phillip Greenbaum | U.S. Army Foreign Science & Technology Center<br>AIAST-RA-CB4<br>220 7th St., N.E.<br>Charlottesville, VA 22901 |

| | |
|---|---|
| Morio Hirano | Onoda Cement Co., Ltd.<br>No. 1-1-7 Toyosu, Koto-ku<br>Tokyo, Japan |
| Masura Honya | Ishikawajima-Harima Heavy Industries Co., Ltd.<br>1-15, 3-Chome, Toyosu<br>Koto-ku, Tokyo 135-91, Japan |
| Yoshihito Ikariyama | Tokyo Institute of Technology<br>O-okayama 2-12-1,<br>Meguro-ku, Tokyo, Japan |
| Masato Kaneko | Mitsubishi Heavy Industries, Ltd.<br>6-22, 4-Chome, Kan-on-Shin-Machi, Nishi-ku<br>Hiroshima 733, Japan |
| Shuzo Kumazawa | Institute of Oceanic Research and Development<br>Tokai University<br>3-20-1 Orido, Shimizu<br>Shizuoka 424, Japan |
| Eichi Manabe | Onoda Cement Co., Ltd.<br>No. 1-7, 1-Chome, Toyosu, Koto-ku<br>Tokyo 135, Japan |
| Yuuki Miura | Kansai Paint Co., Ltd.<br>4-17-1, Higashi-Yawata, Hiratsuka<br>Kanagawa-Ken 254, Japan |
| Hideaki Miyashita | Nippon Steel Corporation<br>1618 IDA, Nakahara-ku<br>Kawasaki 211, Japan/<br>Marine Biotechnology Institute Co., Ltd.<br>2-35-10 Hongo, Bunkyo-ku<br>Tokyo 113, Japan |
| Kei Mori | La Foret Engineering & Information Service Co., Ltd.<br>2-7-8 Toranomon, Minato-ku<br>Tokyo 105, Japan |
| Fumio Nagakura | Mitsubishi Heavy Industries, Ltd.<br>15-1 Tomihisa-cho, Shinjuku-ku<br>Tokyo 162, Japan |
| Hiroyuki Nakayama | Kansai Paint Co., Ltd.<br>4-17-1 Higashi-Yawata, Hiratsuka<br>Kanagawa-Ken 254, Japan |

| | |
|---|---|
| Takahisa Nemoto | Ocean Research Institute, University of Tokyo<br>1-15-1 Minamidai, Nakano-ku<br>Tokyo 164, Japan |
| Ichiro Okura | Tokyo Institute of Technology<br>Meguro-ku<br>Tokyo 152, Japan |
| Hiroaki Shinohara | Tokyo Institute of Technology<br>Ookayama, Maguro-ku<br>Tokyo 152, Japan |
| Hiroyuki Takano | Onoda Cement Co., Ltd.<br>No. 1-7, 1-Chome, Toyosu, Koto-ku<br>Tokyo 135, Japan |
| Kei Ono | MES Tsukuba Research Center<br>Tokyo, Japan |
| M. Yoshitake | MES Tsukuba Research Center<br>Tokyo, Japan |
| Oskar R. Zaborsky | National Research Council, National Academy of Sciences<br>2101 Constitution Avenue, N.W.<br>Washington, D.C. 20418 |

U.S.S.R.

| | |
|---|---|
| Alecsandr N. Asanov | Institute of Chemical Physics of the Academy of Sciences<br>of the U.S.S.R.<br>Moscow 117377, U.S.S.R. |
| Boris P. Atanasov | Institute of Organic Chemistry, Bulgarian Academy of Science<br>1113 Sofia, Bulgaria |
| Peter I. Belobrov | Molecular Architecture Group of Krasnoyarsk Sciencific Center<br>Institute of Biophysics & Kirensky Institute of Physics<br>U.S.S.R. Academy of Sciences, Siberian Branch<br>Krasnoyarsk 660036, U.S.S.R. |
| Ebert Bernd | ZIM, AG Bioelektronik<br>Berlin, GDR |
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| | |
|---|---|
| Albert F. Lawrence | Hughes Aircraft, Inc. |
| Pavel I. Lazarev | Institute of Biological Physics of the U.S.S.R. Academy of Sciences<br>142292 Pushchino<br>Moscow Region, U.S.S.R. |
| Ruth Margalit | Jet Propulsion Laboratory, California Institute of Technology<br>4800 Oak Grove Drive<br>Pasadena, California 91109-8099 |
| Stanislav Nespurek | Institute of Macromolecular Chemistry<br>Czechoslovak Academy of Sciences<br>Heyrovsky Sq. 2<br>162 06 Prague, Czechoslovakia |
| Michail A. Ostrovsky | Institute of Chemical Physics<br>Moscow, U.S.S.R. |
| V. Z. Paschenko | M. V. Lomonosov State University<br>119899 Moscow, U.S.S.R. |
| Andrei Razjivin | Moscow State University<br>Moscow, U.S.S.R. |
| Anwar A. Zakhidov | Uzbek SSR Academy<br>Tashkent, U.S.S.R. |


## C. LITERATURE RECEIVED


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*Mitsubishi Heavy Industries' Giant Product Range* (Brochure from Mitsubishi Heavy Industries, Ltd.).

Appendix D

## ACKNOWLEDGEMENTS

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### 2. International Organizations

INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS
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THE INTERNATIONAL UNION OF BIOCHEMISTRY

### 3. Local Organizations

BIOINDUSTRY DEVELOPMENT CENTER
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