

THE NUCLEUS

February 1992

Of the Northeastern Section of the American Chemical Society

Vol. LXX, No. 5

Monthly Meeting

*W. Orme-Johnson speaks on
Biological Nitrogen Fixation*

Paddlanes, Synthetic Approaches

A Norris Summer Scholar Report

Historical Notes

E. B. Hershberg

Mercury

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Cover: *William Orme-Johnson in his office*

Deadlines: *April 1992 issue: February 21, 1992*

THE NUCLEUS

Dedicated to the Memory of James Flack Norris
Published monthly from October to May by the Northeastern Section of the American Chemical Society, Inc.



The Nucleus is distributed to the members of the Northeastern Section of the American Chemical Society, to the secretaries of the Local Sections, and to editors of all local publications. Forms close for advertising on the 1st of the month of the preceding issue. Text must be received by the editor six weeks before the date of issue.

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The 741st Meeting of the Northeastern Section of the American Chemical Society

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Boston College

5:30 Social Hour, Shea Room, Conte Forum (Athletic Center).
Also at 5:30: Information session for job seekers

6:30 Dinner

8:00 New Chemistry Building, Rm. 130: William Orme-Johnson, Mass. Institute of Technology: *Biological Nitrogen Fixation*

Refreshments will be served after the program.

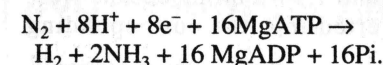
Dinner reservations should be made no later than February 7. Please call Mrs. Karen Piper at (508) 456-8622 or (800) 872-2054 (MA or NH). Reservations not cancelled at least 24 hours in advance must be paid. Members, \$21.00; Non-members, \$23.00; Students and Retirees, \$8.00. **THE PUBLIC IS INVITED.**

The next Meeting will be held on March 12, 1992 at Harvard University: Prof. John S. Waugh of MIT will receive the T.W. Richards Medal. His address will be on "NMR in Chemistry and Alchemy".

Abstract

Biological Nitrogen Fixation

Biological conversion of dinitrogen to ammonia and then to nitrogenous cell components requires the participation of twenty gene products, the maintenance of low pO_2 at high electron transport and ATP production rates, and the provision of an efficient mechanism for removing the cytotoxic product, ammonia. Nitrogenase, a two-component enzyme system, catalyzes the reaction



We have combined spectroscopy, protein chemistry, and genetic engineering approaches in our studies of the structure and mechanism of nitrogenase, including the nature, chemistry, and biosynthesis of the inorganic clusters in the active site of nitrogenase. An integration of the results of our studies, the

kinetic results of Thorneley and Lowe, and the emerging x-ray structures by Bohlen, Reese, and their students, will be presented. Our major current struggle is to understand the structure and chemistry of the molybdenum-iron cofactor, a key component of the catalytic center of nitrogenase. \diamond

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Biography

W.H. Orme-Johnson

William Orme-Johnson was born in Phoenix, Arizona. He attended the Rice Institute and the University of Texas at Austin, earning BSc (1959) and PhD (1964) degrees in Chemistry under the guidance of William Shive. After a year of postdoctoral work with Daniel Ziegler at the Biochemical Institute at Texas, he joined the Enzyme Institute at the University of Wisconsin, Madison, as an NIH fellow and subsequently NIH Research Career Awardee. He became professor of Biochemistry in the Enzyme Institute in 1970, where he was Romnes Faculty Fellow, 1975-9. In 1979 he joined the Department of Chemistry at the Massachusetts Institute of Technology, where he is Professor of Chemistry and Resident Faculty (Housemaster) of Bexley Hall. Professor Orme-Johnson became interested in metallo-biochemistry as a fellow in Helmut Beinert's laboratory at Wisconsin, and has for the past twenty years been engaged in enzymological and biophysical research on methane biosynthesis, biological nitrogen fixation and steroid hormone biogenesis. A recent personal experience (1990) has given him an acute interest in urinary lithogenesis, but his major research efforts remain centered on catalytic mechanisms of nitrogenase and steroidogenic cytochromes P450, using both spectroscopic and genetic engineering approaches. \diamond

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Progress Towards the Synthesis of Paddlanes

by Annette MacDonald¹, Department of Chemistry, University of Massachusetts at Boston

Introduction

Since the publication twenty years ago of work^{1,2,3} drawing attention to the unusual structural properties of paddlanes, these compounds, particularly the [2.2.2.n]paddlanes (1), have provided challenging synthetic targets. Paddlanes in general have a generic shape which is reminiscent of the paddle on a riverboat.² The [2.2.2.n]paddlanes, where n is small (6-12) are of interest because of the distortion of the bridgehead carbon atoms toward pyramidal and square-planar geometries.^{4,5}

We have been exploring the synthesis of two main types of paddlanes. One is based on a 1,3-cyclohexadiene starting compound while the other is an anthracene derivative. Both approaches rely on a Diels-Alder cyclization to form the third bridge, and then elaboration of the molecule will eventually allow incorporation of the fourth bridge to produce the desired paddlane. Progress on the two syntheses will be discussed separately.

Anthracene-Based Paddlanes

The first approach to this type of paddlane was made beginning with 9,10-bis(acetoxymethyl)anthracene (2). Three different Diels-Alder reactions were performed, using (a) maleic anhydride; (b) dimethylacetylenedicarboxylate (DMAD); and (c) 1,2-bis(benzenesulfonyl)ethylene as dienophiles. The reaction of 2 with maleic anhydride proceeded readily upon refluxing in benzene to give adduct 3. We then attempted to selectively hydrolyze the anhydride to the diacid which would then be followed by a double Kolbe reaction (electrolysis) to provide the desired double bond shown in compound 4. However, several attempts at the hydrolysis using varied conditions were only partially successful, and the electrolysis gave

inconclusive results. These somewhat negative findings prompted a search for a new dienophile. DMAD was a particularly attractive dienophile as the Diels-Alder reaction would lead directly to the desired double bond in the third bridge. The addition proceeded smoothly in refluxing xylene to give adduct 5. However, we now were faced with the problem of differentiating the methyl esters from the acetates for elaboration purposes, and this proved to be a formidable problem. Therefore, we moved on to a third dienophile, PhSO₂CH=CHSO₂Ph. This was also a promising dienophile, as a fairly straightforward reduction of the phenylsulfonyl groups would again provide the desired double bond. Unfortunately, the results of this Diels-Alder reaction were again inconclusive, possibly because of the small amounts of material available. This approach is currently being reinvestigated on a somewhat larger scale.

Another approach to the dibenzo-paddlanes began with 9,10-bis(hydroxymethyl)anthracene. We were investigating oxidation of the alcohols to aldehydes in preparation for attachment of the long fourth bridge of the paddlane. A number of oxidations were attempted: PCC, PCC on alumina, Swern conditions, and SO₃/pyridine complex were all used with mixed results. The solubility of the starting diol was a major problem in all cases. Some oxidation was observed, but the reaction never approached 100% conversion.

Cyclohexadiene-Based Paddlanes

Initial work focused on preparation of dimethyl-1,3-cyclohexadiene-1,4-dicarboxylate from the corresponding carboxylic acid. Two methods were utilized: a Fischer esterification or conversion to the bis acid chloride followed by treatment with methanol.

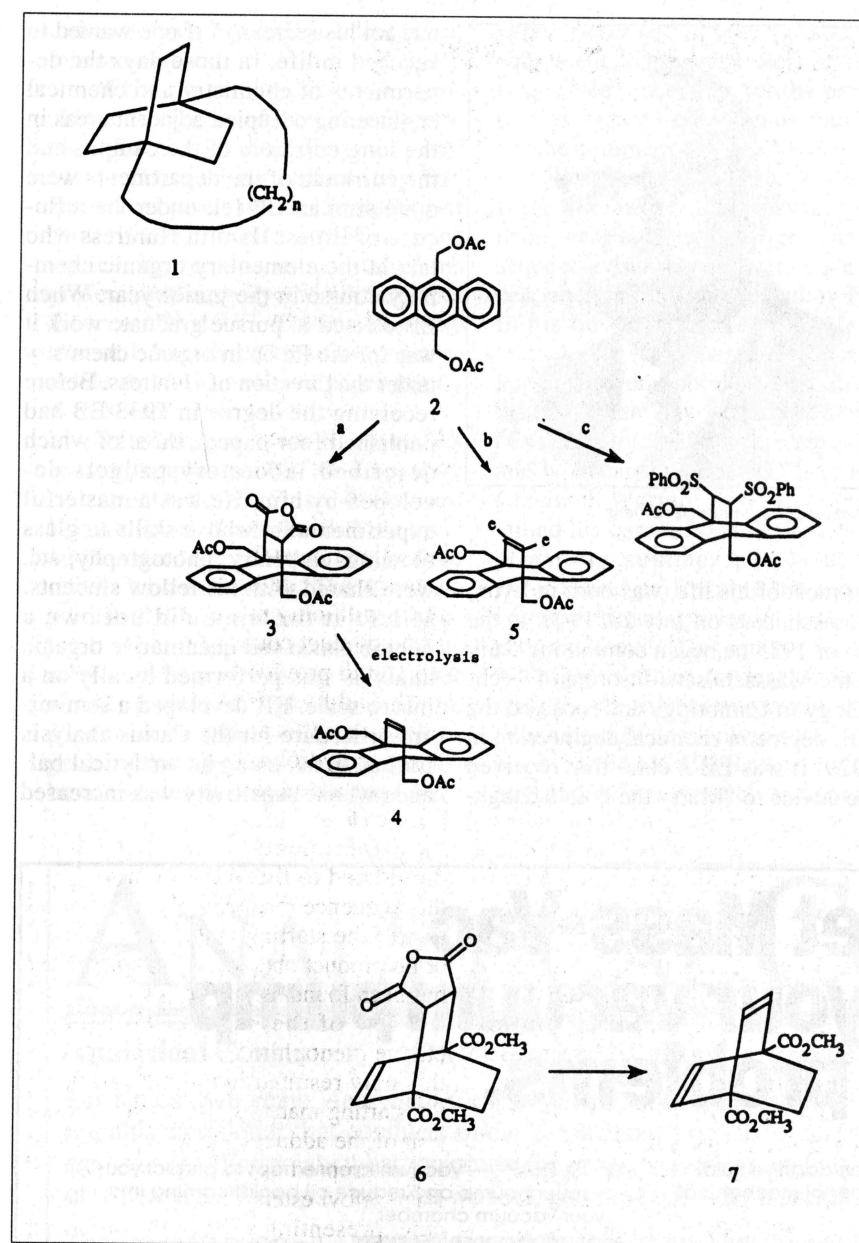
Yields were consistently lower than desired, and various modifications of the procedures gave little if any improvement in the yield. Providentially, this compound became available from Aldrich Chemicals (albeit rather expensive) and a moderate amount was purchased.

Diels-Alder reaction of the cyclohexadiene diester with maleic anhydride proceeded cleanly, although again with only moderate yields. The crude product could be readily recrystallized to provide fine white crystals of the adduct. Previous work had shown that this adduct could be subjected to hydrolysis and electrolysis to produce a double bond in the third bridge (6 → 7).³ Strangely, although the experimental conditions were duplicated to the best of our ability, this sequence resulted only in destruction of the starting material with little or no product obtained. No explanation has been found as yet for this result.

Use of the bis phenylsulfonyl ethene dienophile was attempted, but this only resulted in aromatization of the starting material rather than formation of the adduct. Use of DMAD was not attempted as this would result in four methyl esters present in the molecule, presenting serious problems in differentiation for further elaboration.

In anticipation of future success with this project, 1,12-dibromododecane and 1,10-dibromodecane were converted into the corresponding

- 1991 James Flack Norris Summer Research Scholar at the University of Massachusetts at Boston under the direction of Prof. M.H. Schwartz.
- The name "paddlane" is credited to J.J. Bloomfield, E.H. Hahn, H. Bohm, and D. Ginsburg in *Tetrahedron Letters*, 1973, 507.
- This methodology had been worked out at Smith College by M.H. Schwartz.



diido compounds using a Finkelstein reaction. These will be converted to the dilithio compounds in the future and used to introduce the long fourth bridge into the paddlane molecules. Work is currently continuing in our laboratories on both aspects of this project.

Acknowledgements

The support of the Northeastern Section (through the James Flack Norris Summer Research Scholarship) and of the Chemistry Department of the University of Massachusetts at Boston are gratefully acknowledged.

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- R. Hoffman, R.W. Alder, and C.F. Wilcox, Jr. *J. Am. Chem. Soc.* 1970, 92, 4992. ◇

Nominations

Henry A. Hill Award

Nominations for the Henry A. Hill Award for Outstanding Service to the Northeastern Section should be sent to Dr. William O. Foye, Chair, Awards Committee at 179 Longwood Avenue, Boston, MA 02115 by May 30. Include a resumé of professional activities and contributions to the Northeastern Section. ◇

Philip L. Levins Memorial Prize

Nominations for the Philip L. Levins Memorial Prize should be sent to Karen Piper, Executive Secretary, 19 Mill Road, Harvard, MA 01451 by March 15. This prize is awarded for outstanding performance by a graduate student whose research is in the area of organic, analytical, or environmental chemistry. Please include a biographical sketch, transcripts of graduate and undergraduate grades, description of present research activity, and three references. ◇

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Historical Notes

by Edward R. Atkinson, Amherst, MA

During the national meeting of the American Chemical Society in Atlanta, Georgia in April, 1991 Dr. George de Stevens of Drew University received the first **E.B. Hershberg Award for Important Discoveries in Medicinally Active Substances**. The award is to be made biannually by the American Chemical Society and is funded in perpetuity by the Schering-Plough Corporation to honor the memory of **Emmanuel Benjamin Hershberg**, a chemist who achieved an international reputation in medicinal chemistry while participating in significant advances in the professional and economic status of the corporation.

"EB," as he was known through-



Emmanuel Benjamin Hershberg

out most of his life, was born in Lynn, Massachusetts on July 28, 1908. In the fall of 1925 he began commuting daily to the Massachusetts Institute of Technology in Cambridge and received the S.B. degree in chemical engineering in 1929. It was EB's class that received the advice to "Marry the boss's daugh-

ter, not his secretary" if one wanted to succeed in life. In those days the departments of chemistry and chemical engineering occupied adjacent areas in the long corridors of the campus and the curricula of the departments were quite similar. EB fell under the influence of Ernest Hamlin Huntress who taught the elementary organic chemistry course in the junior year. When EB elected to pursue graduate work it was for the Ph.D. in organic chemistry under the direction of Huntress. Before receiving the degree in 1933 EB had published four papers, three of which described laboratory gadgets developed by him. He was a masterful experimentalist whose skills in glass blowing, carpentry, photography, etc. were shared with his fellow students. M.I.T. at that time did not own a microbalance and quantitative organic analysis was performed locally on a macro scale. EB developed a semimicro procedure for the Carius analysis for halogens, using an analytical balance whose sensitivity was increased

to handle weights with an accuracy of ten micrograms.

When no employment was available in the depths of the Great Depression, EB accepted the Forrest Jewett Moore Travelling Fellowship and spent two years in the laboratory of Paul Karrer at the University of Zurich. Karrer was at the peak of his professional activity and was a Nobel Laureate in 1937. During his stay abroad EB published his first paper as a sole author as well as a paper jointly with Karrer.

Returning to New England EB secured employment in the laboratory of Louis Frederick Fieser at Harvard University and remained there until 1945. Fieser and EB each admired the other's laboratory skills. The 43 papers published during his period in collaboration with Fieser and Fieser's students showed EB's continuing facility for working with others. Most of the papers were in the fields of carcinogenic polynuclear aromatic hydrocarbons and steroid transformations. Five

papers described improving laboratory equipment and several others described large scale procedures for the preparation of organic compounds that were not the commercially available.

With the approach of World War II the emphasis in the Harvard Group underwent a sudden change. The subsequent activities at Harvard have been described in illustrated detail by Fieser in his book, *The Scientific Method* (Reinhold, New York, 1964) which contains several photos of EB. In EB's undergraduate days he was a member of the Reserve Officers Training Corps and he became a reserve officer in the Chemical Warfare Service. He maintained his commission in the CWS by attending summer camps at Fort Devens and performing the required correspondence courses in military science and tactics. He regularly achieved the highest rating for marksmanship with the 45 caliber automatic pistol. When hostilities involving the U.S.A. began in 1942 all CWS reserve officers engaged in war research and teaching

were urged to resign their commissions. EB gave up his captaincy and became a National Defense Research Fellow, working on napalm and other weaponry for Division 19 of the National Defense Research Committee.

It was in 1939 during the Harvard period that EB achieved sufficient financial stability to marry and begin to raise a family. At the time of his death in 1987 he was survived by his wife Charlotte, two sons, a daughter, and four grandchildren.

In 1945 the Schering Corporation was a small pharmaceutical house, recently severed from a German parent by the Alien Property Custodian, and specializing in the manufacture and sale of steroidal sex hormones. EB was hired as director of research and development and instructed to assemble a team of organic chemists to support the expansion of the company's business. In 1948 he and his coworkers were publishing novel chemistry and he ex-

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Historical Notes

continued from page 9

tended the company's product line to include the fields of cortisone-related hormones and antibiotics. Of particular significance was the development of new manufacturing techniques for the drugs prednisone, gentamicin, beta-methasone, dexamethasone, sisomicin, and diprolene. The steroidal 1,4-dienone prednisone enjoyed considerable commercial success following its marketing in 1955. Its potency was markedly greater than that of the natural hormone cortisone and it had a lower toxicity. Today it is the standard of corticosteroid therapy for more than 150 diseases. Because of EB's facility for designing scale-up procedures, production was always equal to market demand. The same can be said for the broad spectrum antibiotic gentamicin that was marketed in 1963 after successful research to isolate, by selective culture, a strain of organism that gave a reasonably homogeneous product.

Prior to EB's retirement in 1973 there were 75 papers and 37 patents bearing the name of EB as senior author or as co-author with associates who were themselves well-known in the field of medicinal chemistry. EB's last patent application, issued just before his retirement, was for a procedure for detecting suspended solids in bottled liquids.

During his career at Schering EB held a series of managerial posts with increasing responsibilities. These included director of R & D (1945-1966), vice president for physical sciences (1966-1970), and vice-president and science advisor, corporate research division (1970-1973).

Following his retirement from Schering, EB joined the H. Reisman Corporation in Orange, New Jersey as vice-president and continued to carry out research on the production of drugs and fine chemicals until his death on January 22, 1987.

Scientists whose names appear in "American Men and Women of Science" are responsible for writing

the material that accompanies their names. In the 13th edition EB listed his professional specialties as the synthesis of hormones; and organic quantitative analysis. The last entry may surprise some but it reveals an early love, just as the "Rosebud" sled did in the famous last scene of the "Citizen Kane" movie. EB's stay at M.I.T. coincided with E.H. Huntress' revival of Samuel Parsons Mulliken's scheme of organic quantitative analysis. Those who studied organic chemistry in the 1930's developed a lasting affection for the procedures of "organic qual" that not only enhanced one's small-scale laboratory techniques but also developed procedures for problem solving that were of great value in later professional life.

EB enjoyed a very happy family life. In his home he pursued his hobby of raising orchids. He was admired within Schering and also in the greater scientific community as a gifted and benevolent leader of research. One colleague has remarked that the substance of EB's talent was matched by his style. He was a gentleman who treated everyone with courtesy and respect. His approval was freely, enthusiastically, and honestly given. His criticism was always measured and impersonal. He enhanced the joys of success and mitigated the distress of failure. ◇

The valuable contributions of Dr. Hershel Herzog and Sir Derek Barton to the above account of EB's life are gratefully acknowledged.

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Workforce Report: Analysis of ACS Members with Functional Limitations

This report on members with various disabilities comes at a very appropriate time: The report is dated December, 1991 and in January 1992 the *Americans with Disabilities Act* took effect which requires organizations, businesses and structures which serve the general public to provide facilities for those with disabilities: Access, architectural and mechanical requirements to allow use by those with physical limitations, provisions for safe access and use by those with limited vision or hearing.

The study showed that among ACS members hearing limitations were the most common, followed by seeing limitations. These, and limitations in walking and lifting, were analyzed in respect to their presence as a function of age, as a function of employment status, and as a function of highest degree earned. It was found that those with a Ph.D. degree were more likely to have severe limitations. A number-pushing statistician could conclude that getting a Ph.D. is dangerous to your health! Obviously, the proper explanation is, that Ph.D.'s are more likely to be in supervisory or administrative positions. Those with significant physical disabilities are more likely to accept or be selected for "desk jobs" which are physically less demanding than those of "bench chemists". However, chemists with functional limitations expressed some dissatisfaction with their rate of advancement.

It will be interesting to see in a decade or two after enforcement of regulations for those with disabilities whether their proportion employed in chemistry will increase. ◇

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Mercury: Stone Age Metal Part III

by James V. Thompson

The conclusion of the article originally published in the January 1991 issue of *THE VORTEX* (California Section). Previous parts are in the February and November 1991 issues of the *NUCLEUS*. (With permission of the *VORTEX* editor, Robert R. Grinstead)

Uses of Mercury

Amalgamation of Gold and Silver and Scrap

In Part I it was mentioned that Vitruvius, an architect during the reign of Roman Emperor Augustus (31 B.C. to 14 A.D.), described the use of mercury to amalgamate gold from embroidery in the clothing of the rich. Pliny (23 to 79 A.D.) mentions amalgamation of

gold and plating with mercury of silver and copper. Such plating can be called a partial amalgamation. In placer mining mercury is used in two major ways. In the first, mercury is placed in the riffles of the sluice box, over which is passed raw ore and water. This is a wasteful use of mercury and much of it is lost to the environment. Much of the so called "free placer mercury" found in California rivers may in fact be such lost mercury. Today the authorities will stop this practice when they find it, however the weekend miner with his pump, sluice box and pickup truck can get away with it. The most satisfactory and safe way to use mercury in placer mining of gold is to first concentrate the gold

with gravity type concentrators, producing a "black sands" concentrate. The black sands are magnetite, ilmenite and at times garnets and minerals in the 3.0 to 3.5 specific gravity class. The gold is mixed with the black sands minerals. If the black sands are excessive the magnetite can be removed at low magnetic intensity and if warranted the ilmenite can be removed at higher magnetic intensities. What remains is gold and non-magnetic minerals. This concentrate can then be batch amalgamated under close control so as not to allow mercury to escape. The amalgam, when the mercury is saturated with gold, is a silver colored plastic compound, and when retorted in a closed system the mercury is recovered for reuse. In the refinery some mercury is bound to be spilled and the drain water from the refinery would pass through a series of traps before discharge. Where hard rock ores that contain gold are being ground, the ground ore and water passes over a series of copper plates that are coated with mercury. These

plates are removed at intervals and scraped to remove the amalgam and retorted as described above. Often amalgam plates are followed by other gold recovery processes such as gravity concentration or cyanide leaching. Amalgamation of gold and silver ores is today a very minor use of mercury, perhaps less than 0.05% of the total consumption.

Agricultural Uses

Such uses include germicides, fungicides, algicides and other uses that depend on the toxic nature of mercury compounds. Needless to say, every effort is being made to phase out mercury compounds that in any way get into the environment. In the past agricultural uses amounted to about 2.85% of the total.

Chemical Uses (Exclusive of Caustic Soda Manufacturing)

The 57th edition of *Handbook of Chemistry and Physics*(3) lists about 100 compounds of mercury in the inorganic list, and there are no doubt many

more organic compounds. In addition to the agricultural uses which are chemical in nature mercury or its compounds are used as catalysts in the manufacture of plastics, resins, acetic acid and other chemicals. The well known "fulminate of mercury", $Hg(CNO)_2$ was used in munitions and blasting caps but this use has been phased out since 1956. (At amusement parks where there were shooting ranges employing .22 caliber rifles the attendants often got mercury poisoning).

Mercury compounds are used in antifouling paints for ship bottoms and in paints for mildew proofing. In pulp and paper manufacture mercury compounds have been used for protective purposes. However, wherever possible mercury compounds are being phased out. Twenty years ago all of the above would have accounted for about 19% of the total mercury consumption.

Dental Amalgams

In the past this use has amounted to about 4.5% per year of the total which would amount to over 180,000 pounds;

that would fill a lot of tooth cavities. While it is still in use for dental work there is agitation to phase it out.

Electrical Apparatus and Instruments

Mercury batteries account for a large usage in this group. Mercury switching devices are in wide use and they are often found in the home. Mercury vapor lamps for street lighting have been in use for decades but in recent times they are giving way to sodium vapor lamps. Mercury rectifiers for changing A.C. current to D.C. have been in use for decades but are being replaced by the so-called "dry" silicon and selenium rectifiers. Public power is A.C. and always on tap and for many applications requiring D.C. the way to go is with the dry type rectifier. However some large electrometallurgical plants (aluminum) may have captive D.C. generators delivering power at point of use voltage (no transformer or rectifier). For most electrical usage there is not much agitation to phase out

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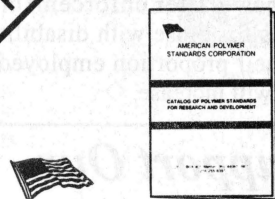
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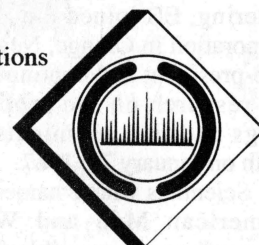
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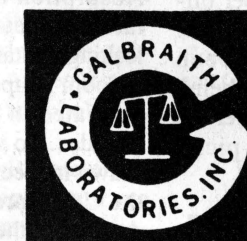
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Mercury

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mercury. The principal environmental danger arises when these devices become damaged, releasing mercury to the environment. However some uses have simply been replaced by more efficient devices such as the sodium vapor lamp and the dry rectifier.

Clinical thermometers employing mercury have been phased out in favor of thermocouple devices with digital readouts (the last time I was in the hospital the nurse used one of these new types, and when it showed that I had a temperature of 112°F she pulled out an old fashioned mercury thermometer that showed 98.6°F.) Mercury manometers for blood pressure and barometers may be around for a while yet, but again the danger is in breakage. For many years the home gas meter had a mercury "blow out" trap that protected the house side of the gas line from overpressure. These have been replaced by other devices.

One of the most recent developments in the use of mercury is mercury cadmium telluride in thermal imaging devices such as the "see in the dark" optical instruments recently in use by U.S. forces in Saudi Arabia.

Pharmaceuticals

Today the medical use of mercury is almost nonexistent as stated in part one of this series. The local drug store still carries an ointment of "yellow oxide of mercury" but the local druggist says that he sells very little.

Mercury Chlorine Caustic Cells

Plants employing mercury cells tie up large quantities of mercury, but consume little of it. A simple description of the cells is as follows: In one cell the anode is carbon and there is a cathode of mercury in the bottom of the cell. Connection is made to the cathode of the next cell by the mercury flowing through an inverted siphon. The second cell also contains a set of carbon anodes. In the first cell, under concentrated brine, sodium is deposited at the mercury cathode and amalgamates

with the mercury. The mercury flows through the inverted siphon (thereby maintaining electrical contact) to the next cell where fresh water is introduced. The sodium is thus liberated and becomes sodium hydroxide with hydrogen being liberated. This is a highly simplified description and there are many designs of mercury cells.

The caustic produced is about 50% NaOH, whereas in the diaphragm type cells it is about 11 to 13% NaOH. Diaphragm cell caustic is also contaminated with brine and must be desalted before or during evaporation. Some industrial plants can use over-the-fence weak caustic, but the advantage of producing 50% caustic directly is obvious. Many users are willing to take 50% caustic in tank car shipments.

The problem with mercury caustic plants is in the "consumption" of mercury. Here we should read "loss". The older literature states that losses are about 0.2 pound per ton of caustic. Even if very tight control has reduced this loss to 0.1 pound per ton, the loss ends up in discharges from the plant. It is here that we get our parts per billion in the tuna fish, but any parts per billion is too much for the authorities. Some mercury plants have been phased out and no new ones are being built in the United States. However the overseas folks may not be so picky about their tuna fish.

Mercury as a Heat Transfer Medium

Engineers have long dreamed of a power plant based on a mercury boiler and mercury turbine where the mercury vapor condenser is a water boiler, the steam from which is operating another turbine. Indeed, a demonstration size plant was built but soon abandoned. No doubt the nuclear energy folks have toyed with the idea. Mercury vapor seems to be somewhat like hot pressurized Bunker C oil - it will sweat through seemingly tight pipe joints and brittle welds. In the late 30's *Popular Mechanics* had an article with a cut-away drawing of the mercury boiler and turbines. But the big leak came. Several tons of mercury were released into the plant. It was said to be warm

but not too hot to touch. Eight men with no protective equipment were assigned to clean up the spill. Their objective was to recover the mercury, not get rid of it. Five came down with mercury poisoning and one died.

Mercury Poisoning

Knowledge of mercury poisoning has increased during the past 50 years, although it was known to the ancients. People working in a low grade open pit mercury mine are at minimum risk but none the less they should have dust masks and hit the shower at the end of the shift. Underground miners are at somewhat higher risk, and those working in and around the furnacing plant and condensers are at a maximum risk. Metallic mercury and all of its compounds are toxic. We will skip the tragic details of mercury poisoning but one can get it from exposure to the skin (never again will I silver any pennies), inhaling even minute amounts of the vapor of mercury or its compounds and ingesting mercury in any form. The consensus is that no mercury is the way to go, never mind "allowable limits". Absorption through the skin and the fact that open containers of mercury or leaking containers give off some vapor at room temperature has only been appreciated in perhaps the last several decades. So strict have the rules been drawn in recent years that one report of the U.S. Bureau of Mines predicted a demand in the year 2000 of zero. However they backed off from this and estimated a U.S. demand of 4000 76 pound flasks in the year 2000.

Economics

There is an oversupply of mercury on the world market. The only U.S. mercury mine in northern Nevada has shut down. A recent price was \$200 per flask or \$2.63 per pound. If a mine is producing 8 pounds per ton of ore the gross is \$21.00 per ton, and the Nevada mine has about this value and apparently could not continue to operate at the present price.

The world production has been drifting downward, as shown in the

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Board of Directors

Condensed Minutes, Meeting of November 7, 1991

by Michael J. Hearn

Treasurer's Report: J. Piper presented the status of current funds for October and some budget adjustments. The Board APPROVED the report and the budget adjustments.

Committee Reports:

Awards: W. Foye reported that the committee had identified two high school teachers for nomination for awards from a satisfactory field of proposed nominees.

Constitution and Bylaws: A. Heyn reported that at the Section meeting to follow on this date members attending would be asked to vote on amendments to the NESACS documents. A. Dey informed the Board on the consequences of the Americans with Disabilities Act. **Education:** C. McGowan stated that the manuscripts from Norris Summer Scholars were in hand and will be published in the *NUCLEUS*. As requested, information on past Norris Scholars is being compiled.

Hospitality: Other sites for meetings and the dinners preceding them are being investigated in order to keep dinner costs manageable.

Publications: *NUCLEUS* funds are in good shape and prospects for 1992 are good: Cost to the Section will be less due to economies introduced.

Professional Relations: M. Simon reported that attendance at the October 24 Professional Relations Meeting was lower than expected, possibly due to too many Section meetings within a short time frame.

Program Committee: D. Phillips announced that the speaker for the January meeting will be Dr. S. Fazio on capillary electrophoresis.

Public Relations: The new chairman, Bill Schmidt was introduced to the Board and discussed public relations during National Chemistry Week.

Mercury

continued from page 14

table at the end of Part I (February 1991 *NUCLEUS*, page 22).

Mercury is not a growth industry.

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1. Agricola, *De re Metallica*, translation by H.C. Hoover and L.H. Hoover, from the Latin edition of 1556.
2. D.M. Liddell, *Handbook of Nonferrous Metallurgy; Recovery of the Metals*, McGraw-Hill, 1945.
3. R.C. Weast, *Handbook of Chemistry and Physics*, 57th edition, CRC Press, 1977.

L.J. Goldwater, *A History of Quicksilver*, York Press, 1972.

D.A. Brobst and W.P. Pratt, editors; *United States Mineral Resources*, USGS Professional Paper 820, 1973

C.L. Mantell, *Industrial Electro-Chemistry*, McGraw-Hill, 1950

Staff, U.S. Bureau of Mines, *Mineral Facts and Problems*, 1985.

R.G. Reese, Jr., *Mercury, 1988 Minerals Year Book*, U.S. Bureau of Mines.

L.A. Wright, *Mineral Commodities of California*, California Division of Mines and Geology, Bulletin 156, 1957.

Encyclopedia Britannica, 1966 edition. ◇

Continuing Education: A. Viola described the proposed symposium on "Chemistry in Electronics", to be held at Northeastern University.

National Chemistry Week: V. Wilcox reported on the very successful program held at the U. of New Hampshire with about 1000 children on hand for the chemistry magic show on Halloween night and a strong showing for the week-end event.

Old Business: J. Piper requested that committees present requests for 1992 budgets. The Board discussed the positive and negative aspects of maintaining a surplus chemicals exchange without taking action at this time.

New Business: There was none. ◇

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February 3

Dr. Michael Overcash
(North Carolina State University)
“NCS Pollution Prevention Research Center: A Chemical Engineering Perspective”
Tufts University
(Chemical Eng., Medford Campus)
Audio Visual Rm, 4 Colby Street, 2:30 pm

February 5

Dr. Edward J. Brush
(Tufts University)
“Enzymology of Nitriles, Cyanohydrins and Cyanide”
University of Massachusetts Dartmouth Science and Engineering Bldg (Group II), Rm 305 at 4:00 pm

February 6

Professor Stuart Licht
(Clark University)
“Recent Developments in Photoelectrochemical Solar Cells”
Boston College
New Chemistry Bldg, Rm 130 at 4:00 pm

February 10

Dr. Alaric Naiman (Shipley Co.)
“From Rocker Panels to Multichip Modules: Applications of Electrodeposition to Electronic Interconnection”
Tufts University
(Chemical Eng, Medford Campus)
Audio Visual Rm, 4 Colby Street, 2:30 pm

Professor John Caradonna (Yale Univ.)
“Chemistry of Metal Binding Sites in Mutant Thioredoxins”
Brandeis University
Gerstenzang 122 at 4 pm

February 11

Professor Tohru Fukuyama
(Rice University)
“Synthetic Studies on Lelnamycin”
Boston College
New Chemistry Bldg, Rm 130 at 4:00 pm

February 12

Dr. David McFadden (Boston College)
“Free Electrons as Reactants in the Atmosphere”
University of Massachusetts Dartmouth Science and Engineering Bldg (Group II), Rm 305 at 4:00 pm

February 13

Professor Peter Lansbury (MIT)
“Synthetic and Structural Studies of Amyloid Protein of Alzheimer's Disease”
Boston College
New Chemistry Bldg, Rm 130 at 4:00 pm

February 19

Dr. Charlene M. Mello (Army Materials Testing Laboratory, Natick)
“Recombinant Spider Silk Proteins for Composite Fibers”
University of Massachusetts Dartmouth Science and Engineering Bldg (Group II), Rm 305 at 4:00 pm

February 20

Professor Michelle Millar
(SUNY Stony Brook)
“Metal-Thiolate Complexes as Analogs for Metal-Cysteine Centers in Proteins”
Boston College
New Chemistry Bldg, Rm 130 at 4:00 pm

February 24

Dr. Victor Shashoua
(Harvard Medical School)
“Chemistry and Cell Biology of Long Term Memory: Involvement of Neurotrophic and Extracellular Protein Factors”
Tufts University
(Chemical Eng., Medford Campus)
Audio Visual Rm, 4 Colby Street, 2:30 pm

Professor William Lipscomb
(Harvard University)
“Structure and Function in Allosteric Proteins”

Brandeis University
Gerstenzang 122 at 4 pm

Professor Tadhg Begley
(Cornell University)
“Light-Dependent Enzymes: Mechanistic Studies on a Novel Class of Biocatalysts”
Harvard University
MB-23 at 4:15 pm

February 27

Professor Edwin Jahngen
(University of Lowell)
“Approaches to the Total Synthesis of Vincristine and Vinblastine”
Boston College
New Chemistry Bldg, Rm 130 at 4:00 pm

Notices for the Nucleus Calendar should be sent to:

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