THE NUCLEUS

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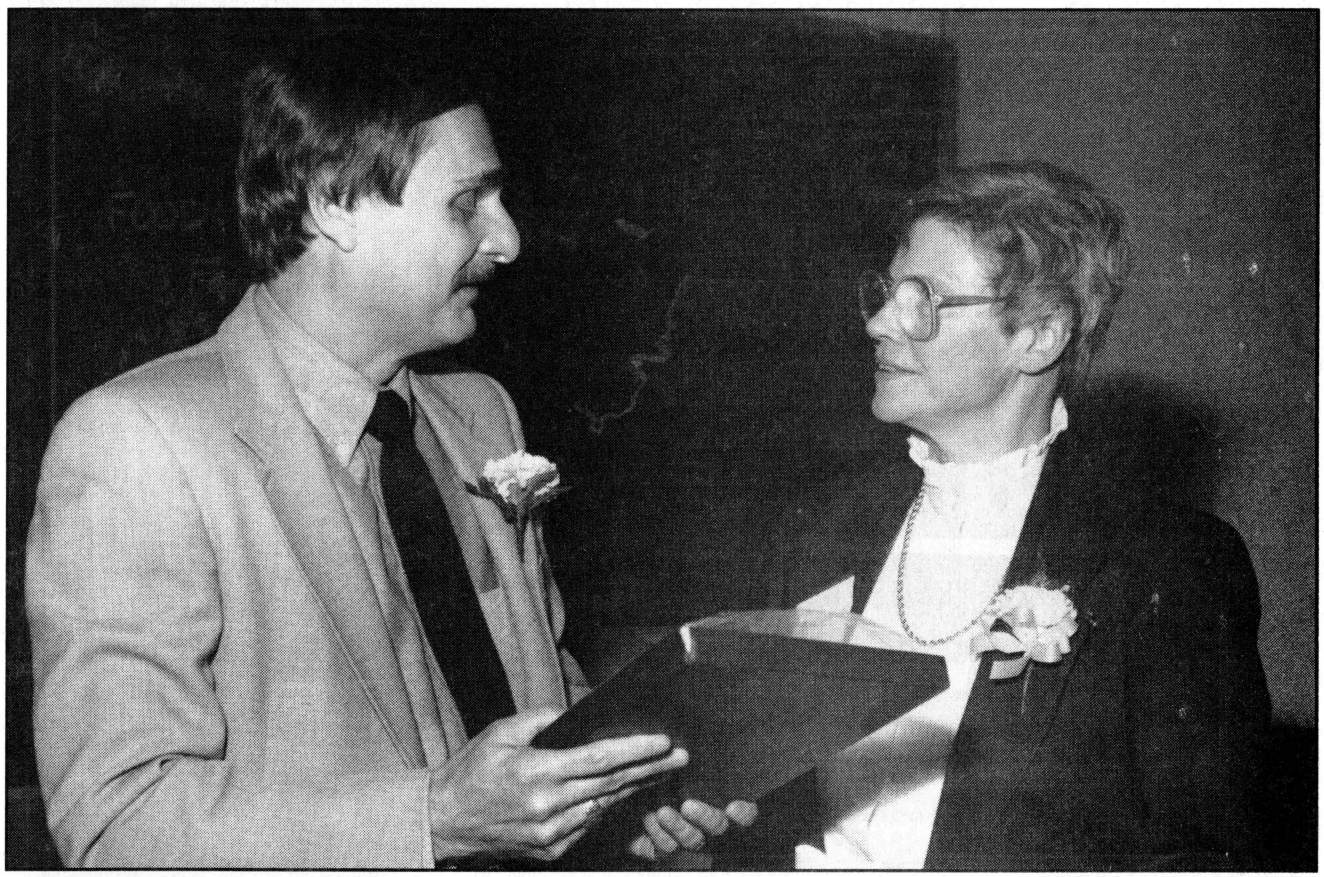

Monthly Meeting

AIDS Symposium
Jointly with the Medicinal Group

Environment Report

Where has the Ozone gone, and how does it happen?

Panel Discussion

Panel Discussion at Nobel Laureate Meeting on October 17

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Cover: *Valerie Wilcox receives the Henry A. Hill Award for her contributions to the Northeastern Section from Chairman Charles E. Kolb, Jr. (Photo by A. Fingland)*

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THE NUCLEUS

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Biography

Choung Un Kim

Choung Un Kim was raised and educated in Japan and came to the United States in 1967. After his Ph.D. work at the University of Oregon, he completed two Post Doctoral fellowships with Professors S. Masamune (MIT) and E. J. Corey (Harvard University). Since joining Bristol-Myers Squibb in 1973, he spent about 13 years in antibacterial research. Mainly, he was involved in the semi and total synthesis of beta lactam antibiotics including carbapenems. In 1986, he started work on an antiviral project aiming at new agents for herpes viruses and HIV. Currently, he is involved in the development of retinoids for clinical applications.

Abstract

Rational Design of HIV Reverse Transcriptase Inhibitor

A number of 2',3'-dideoxy (dd) and 2',3'-didehydro-2',3'-dideoxy (d4) nucleosides have been shown to inhibit *in vitro* HIV-induced cytopathogenicity. Several of these compounds, such as ddI, ddC and d4T are currently in clinical trials. These compounds, as their 5'-triphosphates, inhibit HIV reverse transcriptase by competing with the natural substrate at the same binding site on the enzyme. One logical approach to the discovery of new and potent HIV inhibitors involves the design of phosphonate analogues where the phosphate moiety is changed to isosteric and isoelectronic phosphonates. Those enzymatically and chemically stable phosphonate analogues, which mimic the nucleoside monophosphates, bypass the initial enzymatic phosphorylation and could potentially be more effective antiviral agents against HIV.

Biography

Vincent Jay Merluzzi

Vincent Jay Merluzzi was born in Waterbury, Connecticut. He received his B.A. degree from Northeastern University and his Ph.D. degree in Microbiology from Boston University. He was a postdoctoral fellow at Sloan-Kettering Cancer Center and later both a Research Associate and Assistant Member. He then joined the staff at Boehringer Ingelheim Pharmaceuticals, Inc. as a Senior Principal Scientist in 1986 and soon became a Section Leader in Viral and Cancer Immunology. He also has an appointment as Professor of Biology at The City University of New York. His work between 1970 and 1985 centered around modulating the immune system specifically with biological response modifiers as a means of enhancing cellular immunity toward infectious diseases and cancer. Much of the work was focused on T-cell growth factors and specifically the use of Interleukin-2 (IL-2) for induction of non-MHC restricted cytotoxic T-cells.

From 1986 to the present time, his work focused on infectious disease, specifically human viral pathogens. Recent studies have been published in *Cell* in 1989 and in *Nature* in 1990. In December of 1990, an article published in *Science* disclosed the discovery of a novel non-nucleoside inhibitor of HIV-l reverse transcriptase and HIV-1 virus replication.

Abstract

A Novel Non-Nucleoside Inhibitor of HIV-1 Reverse Transcriptase and HLV-1 Replication

Human immunodeficiency virus type 1 (HIV-1) is the retrovirus responsible for 95% of the acquired immunodeficiency syndrome (AIDS) cases in the world. The complicated life-cycle of this virus presents many challenging areas for intervention. Our laboratories have concentrated on prevention of the early phase in proviral synthesis, specifically interruption of the RNA > DNA metabolic process by interfering with the viral enzyme, reverse transcriptase (RT). From a series of compounds originally synthesized as muscarinic antagonists, we have discovered a series of dipyridodiazepinone inhibitors of HIV-l RT polymerase. A synthesis program based on potency for RT as well as a favorable metabolic and pharmacological profile has led to several potent RT antagonists. One compound, BI-RG-587 (nevirapine) has demonstrated a high degree of activity against HIV-l RT and HIV-l replication, but is not active against feline leukemia virus RT, simian immunodeficiency virus RT and HIV-2 RT. The inhibition by nevirapine is non-competitive with respect to both template-primer and nucleotide substrates. The absence of an effect on K_m for either substrate indicates that nevirapine interacts with HIV-l RT at a site distinct from template-primer or nucleotide binding sites. In addition, nevirapine does not inhibit any mammalian DNA polymerase (alpha, beta, delta or gamma). Nevirapine inhibits HIV-l replication in c8166 T cell cultures as determined by inhibition of cytopathic effect (CPE) and inhibition of p24 production. Many HIV-l isolates have been tested and in all cases, nevirapine was effective in reducing CPE and p24 production. Maximum inhibition was also achieved in all isolates and strains. ◇

December Meeting

The 739th Meeting of the Northeastern Section of the American Chemical Society, jointly with the Medicinal Chemistry Group
AIDS Symposium

Thursday, December 12, 1991
Boston College, Shea Room of Conte Forum (Athletic Complex)
(see map on p. 7)

3:00	Coffee
3:30	Choung Un Kim, Bristol-Myers Squibb Co. *Rational Design of HIV Reverse Transcriptase Inhibitor: Phosphonate Isosteres of 2', 3'-Dideoxy and 2', 3'-Didehydro-2'-3'-dideoxynucleoside Monophosphates*
4:30	Vincent J. Merluzzi, Boehringer Ingelheim Pharmaceuticals, Inc. *BI-RG-587, a Novel Non-Nucleoside Inhibitor of HIV-1 Reverse Transcriptase and HIV-1 Replication*
5:30	Social Hour
6:15	Dinner
7:30	Julian Adams, Boehringer Ingelheim Pharmaceuticals, Inc. *SAR and Mechanistic Action of Dipyridodiazepinones: Novel Non-Nucleoside Inhibitors of HIV-1 Reverse Transcriptase*

Refreshments will be served after the program.

Dinner reservations should be made no later than December 6. 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.

Parking will be provided in the garage off Beacon Street close to the Conte Forum.

Next Meeting: January 9, 1991 at Boston College. Dr. Steven Fazio (Sandoz Corp.) will speak on Requirements of Capillary Electrophoresis for Pharmaceutical Applications.

Biography

Julian Adams was born in Quebec City, Canada. He earned his B.Sc. degree majoring in Chemistry from McGill University in 1977. He pursued graduate studies at M.I.T. where he was awarded a Ph.D. degree in Chemistry in 1981. He then took up post-doctoral studies in 1981 at Columbia University in the laboratory of Professor Gilbert Stork, where he held a National Sciences and Engineering Research Council of Canada post-doctoral fellowship. Upon completing his academic studies in synthetic organic chemistry, he joined the medicinal chemistry department of Merck Frosst Canada Inc. He was promoted in 1986 to research fellow. In 1987 he moved to Bio-Mega Inc. as the Associate Director of Chemistry. He then moved to Ridgefield, CT. where he is currently the Director of the Medicinal Chemistry Department at Boehringer Ingelheim Pharmaceuticals, Inc.

Dr. Adams has focused his research interests in drug discovery and development and has a diverse background in several therapeutic areas. While at Merck he worked on the biosynthesis of leukotrienes and the design of inhibitors of the 5-lipoxygenase cascade. At Bio-Mega he worked briefly in cardiovascular research in the area of peptide mimetic ANF agonists. More recently he has turned his attention to the design of non-nucleoside based antiviral agents for herpes infections, targeting the herpes ribonucleotide reductase enzyme. His work in HIV-1 research has lead to a non-nucleoside approach to inhibiting viral reverse transport. Dr. Adams is also investigating new approaches in immune regulation. ◇

Abstract

Nevirapine (BI-RG-587) was synthesized in our laboratories and found to be a selective and specific inhibitor of human immunodeficiency virus type 1 (HIV-1) by inhibiting the reverse transcription of viral RNA to proviral DNA (See previous abstract). The structure activity relationships of the tricyclic dipyridodiazepinones will be reviewed as we tuned the properties of the compounds to maximize inhibition of HIV-1 reverse transcriptase and optimized the bioavailability.

Preliminary enzyme kinetic analysis indicated that nevirapine did not bind to the RT catalytic site. In order to further explore the mode of action of the drug several approaches were adopted including photo-affinity labelling of the enzyme, trypic mapping, and site-directed mutagenesis. It was determined that nevirapine binds HIV-1 RT primarily in the region encompassing amino acids 181-188. Analysis of the primary sequence in this region explains why nevirapine is selective for HIV-1 RT and does not inhibit other retroviral RT enzymes.

Other non-nucleoside inhibitors such as the TIBO compounds or L-697,661 and analogs have also been described and bind to HIV-1 RT at the same site as nevirapine. Using molecular modelling techniques we were able to overlay the different classes of non-nucleoside inhibitors and further define the spatial and pharmacophoric elements that we believe adequately fit the SAR data. A comparative analysis will be presented. ◇

Science and Public Awareness: Where Do the Responsibilities Lie?

A panel discussion at the October 17, 1991 meeting of the Section

Based on a report by M.S. Simon.

Participants: Konrad Bloch and William Lipscomb, Nobel Laureates; S. Allen Heininger, President of the ACS; Vicki Croke of the Boston Globe; Katie Stygall, Moderator.

Stygall asked whether an understanding of the benefits of science by the public is the responsibility of the scientist, of scientific organizations, such as the ACS or of the press? Heininger responded that the ACS has a major role in improving the public's understanding because individual scientists do not communicate well with non-scientists. With a $225 million budget for publications, these primarily address other scientists. Volunteers are needed who communicate well with the public. Communication with the press also needs improvement. This is being addressed presently.

Bloch pointed out that chemistry has the special problem of having its own language. Only very few chemists are able to communicate their work effectively to the public. Another barrier is the public image of chemistry as damaging the environment, illustrated by the fact that DuPont's former slogan "Better Living Through Chemistry" is no longer used. To the public, especially its younger members, "chemical" means "toxic".

Lipscomb commented that this problem of communication has been very difficult. The summer teaching programs for high school teachers at universities are no longer given by the National Science Foundation. Lipscomb has taught Kentucky high school students during the summer. The program has been successful because the subject is developed from first principles about topics of concern: environment, recombinant DNA, etc.

Such courses have to be taught very carefully. Judging by the increased attendance, the program is apparently successful: Over 100 students take the course now. Students find that more new words have to be learned than in taking a foreign language; added to that, the new words represent new ideas which require a change in thinking. He illustrated several common fallacies: 'all chemical reactions give off heat' (not so - adding sugar to water lowers the temperature), or 'heat always causes materials to expand' (heating a stretched rubber band contracts it!).

How can one communicate risk-benefit analysis? The press usually exaggerates the risks and does not address the damage due to alternatives: Coal has caused far more deaths than atomic energy.

Chemistry presents benefits as well as risks, but press reports usually dwell only on the risks.

When interviewed in Europe, reporters have some scientific background since science is included in the high school curriculum as a matter of course. Also, these reporters will have done some homework ahead of time and looked up the background so they can ask knowledgeable questions. Here reporters are unschooled in science. The press should develop science writers who have a basic knowledge of science.

Croke commented that the gap between the scientific community and the press is widening. Scientists don't think like press people, and vice versa. Most reporters are liberal arts majors and are scared off by science, and especially math.

Bloch commented that he has never seen a newspaper report where chemical formulas were used. In Europe science is reported professionally with no attempt to hide the hard science. He thinks that chemistry should be a mandatory high school subject.

Heininger added that when he was an undergraduate at Oberlin, he was required to take a Music Appreciation course. There should be chemistry appreciation courses for non-science majors. This need is being reviewed currently. Lipscomb agreed.

Stygall asked Croke how we could do a better job of educating the public in chemistry? Croke replied that this is a tough problem: Scientists don't think of their work in terms of making a "good story". If there is a good story, journalists would respond eagerly.

After a comment from the audience, Heininger commented that, yes, science can be introduced at a young age. The ACS has not addressed this matter. Their programs were directed to the high-school level. The problem is that grade-school teachers usually lack a science background and thus only perpetuate the faulty public image of science and chemistry with emphasis on the risks, not the benefits of science.

The question was raised: How do we get scientists to be inspired teachers?

Lipscomb responded that few scientists love to teach at the lower levels. Colleges of education lack science courses; this is at the root of the problem.

Stygall commented that the very people who are afraid of science are likely to go into teaching.

Dr. Becker from the audience commented that it is important to avoid talking down to teachers. He suggested that there are many retired chemists and chemical engineers who could be stimulated to teach the excitement of science. Because of their own experience they will have stories how their chemical careers made for a better life of the public.

To address the problem of lacking science background in teachers, the laws in all states would have to be changed to increase science literacy. ◇

Sixth Annual Holiday Chemistry Lecture

"Once Upon a Christmas Cheery in the Lab of Shakhashiri"

Professor Bassam Shakhashiri
University of Wisconsin

assisted by his elves

Monday, December 30, 1991
4:00 and 7:30 p.m.
MUSEUM OF SCIENCE
BOSTON, MASSACHUSETTS

A Winter's entertainment for the entire family!

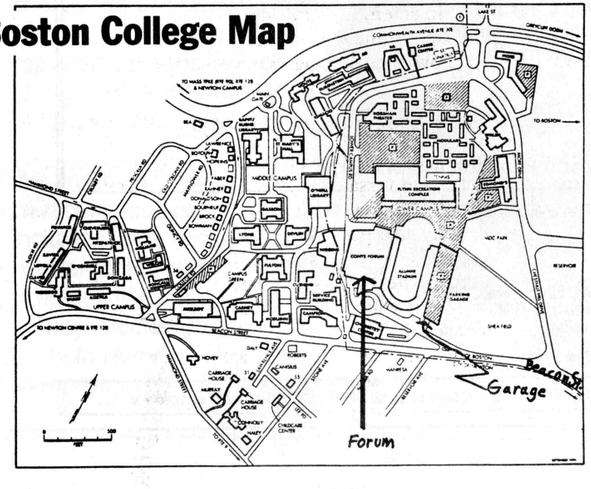
For tickets please send a self-addressed stamped envelope to
Ms. Karen Piper
19 Mill Road, Harvard, MA 01451
ACS Northeastern Section
508/456-8227 or 800/872-2054

Nominations

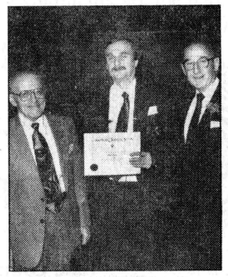
Philip L. Levins Memorial Prize

Nominations for the Philip L. Levins Memorial Prize should be sent to Karen Piper, Executive Secretary, 19 Mill Road, Harvard, MA 01451 by February 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, a description of present research activity, and three references. ◇

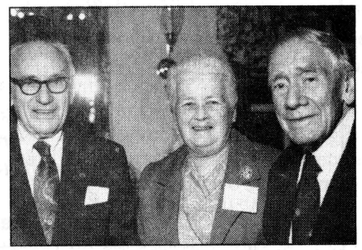
Boston College Map



At the October 17 Meeting



Max Taitel, 50 year member, is congratulated by S. Allen Heininger, President of the ACS, Charles E. Kolb, Chairman of the Northeastern Section in the center.



Dr. Robert O'Malley (50 year member), Mrs. O'Malley, Dr. J. Horace Faull (50+ year member) at the reception

Panel participants (L to R): Allen Heininger (president of the ACS), Konrad Bloch (Nobel Laureate), Katie Stygall (moderator), Vicki Croke (Boston Globe), William N. Lipscomb (Nobel Laureate)

Discussing the issue: Katie Stygall and Vicki Croke *(Photos by A. Fingland)*

Board of Directors

Condensed Minutes, Meeting of June 6, 1991

By Michael J. Hearn, Secretary

The meeting was held at the home of Dr. M. Simon in West Newton.

Officer's Reports: The meeting being informal, no officer's reports were given.

Committee Reports:
Education: Two secondary school teachers have requested funds to attend an ICE summer program. The Chairman and Treasurer will arrange partial funding. Other sources for funding may also be available. A budget item for this purpose is to be included in the future. A request from the NEACT for additional funding is to be denied because three applicants have been funded through Newell grants.
Publications: The summer issue will be 8 pages, deadline advanced a week in order to allow for the reservation deadline.
Public Relations: The new chair is Dr. William Schmid, formerly active for 30 years in the Corning, NY Section.

Other Committees:
Public Service: Dr. Samuel stated that Dr. Ellis, Director of the Science Museum, has stated his desire to continue cooperation with the Section, such as hosting Chemistry Week activities, the Holiday Lecture and High School Symposia. In early November there will be a public lecture on "Nutrition and Health" co-sponsored by the Section and the Nutrition Institute, to be held at Framingham State College.

Old Business: A. Pavlath, Director-at-Large of the ACS and E. Hopkins, former chair of the ACS Professional Relations Committee, led a discussion of the proposed changes in governance structure of the ACS as they apply to the professional relations concerns: Combining the committees on Professional Relations, Economic status and PROPAC into a single Society Committee for the purported purpose of increasing efficiency and eliminating overlap.

Dr. Kolb asked those who aspire to service in offices in the national society to let him know, so proper nominating procedures can be started.

Dr. E. Becker is to be requested to attend the Local Officer's Meeting at NERM on June 25, 1991 in Amherst, MA.

New Business:
Long Range Planning: Dr. Kolb pointed out that two recommendations of the 1990 Long-Range Planning Committee report (A. Dey, Chairman) have been implemented: (1) the Educational Task Force, and (2) the suggestion that professional symposia precede evening meetings. Two such formats are planned for the fall. A mini-task-force, consisting of C. Kolb (chair),

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Stratospheric Ozone Depletion

I. Freezing Out Freons®

C.E. Kolb
Center for Chemical and Environmental Physics
Aerodyne Research, Inc.

Perhaps no environmental issue as vividly demonstrates the impact man-made chemicals can have on nature as the predominantly chlorine-driven catalytic destruction of stratospheric ozone. This column will summarize the historical development of our current concern for the stratospheric ozone layer and present a synopsis of the chemical threats to its integrity. Next month's column (II. Holes at the Poles) will present the fascinating chemistry which leads to the continental scale "ozone holes" now observed each austral spring over the Antarctic, as well as the similar, but smaller ozone depletions observed over the Arctic.

Unless you work on a long distance aircraft crew you spend almost all of your life in the troposphere, which extends from the Earth's surface to the tropopause, the troposphere's boundary with the stratosphere. The tropopause can be as low as 8 km over the poles and as high as 18 km over the equator.

Above the tropopause the stratosphere extends up to approximately 50 km altitude. The atmosphere cools significantly as you go up in altitude, until you reach the tropopause, then it gradually heats up until you reach the top of the stratosphere. In general, however, the stratosphere is a very cold place with temperatures dipping as low as 180°K (-93°C) and with lower and mid-stratosphere (10-35 km) mean temperatures in the 195-245°K range.

The stratospheric ozone layer is the reason that the stratosphere warms with altitude. Ozone intercepts solar ultraviolet (UV) radiation entering the stratosphere from the top. Since the O-O_2 bond in ozone is only about 1 eV (101.4 kJ/mole to be precise) while the solar photons strongly absorbed by ozone are in the 4 to 6 eV range, the photoabsorption process blows the receiving O_3 molecules apart, with most of the excess energy directly or indirectly heating the surrounding atmosphere.

$$O_3 + h\upsilon \rightarrow O_2 + O \qquad 1)$$

In the absence of perturbing trace reactants, most of the atomic oxygen formed in reaction 1 reforms ozone in a termolecular reaction:

$$O + O_2 + M \rightarrow O_3 + M \qquad 2)$$

where M = O_2 or N_2. There is one process which destroys "odd oxygen" (O and O_3) even in the absence of other trace chemicals:

$$O_3 + O \rightarrow 2\,O_2 \qquad 3)$$

However, the atmosphere also continuously replenishes atomic oxygen due to photodissociation of O_2 by shorter wavelength ultraviolet radiation (<240 nm) at altitudes above the stratosphere:

$$O_2 + h\upsilon \rightarrow 2\,O \qquad 4)$$

Sidney Chapman first proposed reactions 1-4 as the explanation for the stratospheric ozone layer in 1930.

The principal beneficiaries of stratospheric ozone's self-sacrifice are not the modestly warmer stratospheric air molecules, but living things on or near the Earth's surface. Life, as we know it, has evolved in the absence of high levels of the mid-ultraviolet radiation (wavelengths of ~310 to ~240 nm) which are filtered out of the solar spectrum by ozone absorption (wavelengths shorter than ~240 nm are removed by other atmospheric species, including O_2 and N_2). A change in the ozone layer affects such life. It is now commonly accepted that each 1% decrease in the mean ozone level will allow enough additional ultraviolet radiation to reach the surface to cause about a 2% increase in human skin cancers. Other effects of increased ultraviolet radiation in the lower atmosphere and at the surface include: crop damage, phytoplankton and zooplankton kills; eye cataracts; and possibly, climate change. Research aimed at quantifying these and other consequences of stratospheric ozone depletion is currently underway.

While the stratospheric ozone layer is a large atmospheric structure, with high ozone concentrations distributed principally between 15 and 40 km and peaking near 25 km, it does not contain an overwhelming number of ozone molecules. If all of the O_3 in the stratosphere were collected and brought to atmospheric pressure at the Earth's surface, it would form a layer only 2.5 to 3 mm thick. Thus, it may not be surprising that our activities can add enough trace chemical reactants to the stratosphere to significantly perturb the ozone layer's composition.

By the 1960's atmospheric scientists were aware that models based solely on reactions 1-4 predicted more than the measured amounts of stratospheric ozone. Loss mechanisms for stratospheric odd oxygen, other than reaction 3, were clearly important. One major loss process was identified in 1970 by Paul Crutzen, a Dutch citizen, now at the Max Planck Institute for Chemistry in Mainz, Germany. Crutzen realized that the nitrogen oxides (principally NO and NO_2) could catalytically destroy stratospheric odd oxygen:

$$NO + O_3 \rightarrow NO_2 + O_2 \qquad 5)$$

$$NO_2 + O \rightarrow NO + O_2 \qquad 6)$$

$$\text{Net: } O_3 + O \rightarrow 2\,O_2 \qquad 3)$$

Thus, even though most NO_2 formed in reaction 5 would photodissociate

$$NO_2 + h\upsilon \rightarrow NO + 0 \qquad 7)$$

with the O reforming 0_3 via reaction 2, enough odd oxygen would be lost through reaction 6 to significantly reduce stratospheric ozone levels. Work by Crutzen, Michael McElroy and coworkers at Harvard University and Marcel Nicolet and colleagues in Belgium established that the major source of stratospheric NO_x ($NO+NO_2$) was the reaction of nitrous oxide (N_2O) with excited oxygen atoms, O (^1D):

$$N_2O + O(^1D) \begin{cases} \rightarrow 2\,NO \\ \rightarrow N_2 + O_2 \end{cases} \qquad 8)$$

About 58% of the time reaction 8 proceeds to produce 2 NO molecules rather than $N_2 + O_2$; the reactant $O(^1D)$ is efficiently formed by reaction 1. Nitrous oxide enters the atmosphere at the Earth's surface and is destroyed by photodissociation and reaction 8 when it reaches the stratosphere. It is produced by microbial metabolism in

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Stratospheric Ozone

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waters and soils as well as by certain combustion sources. Work by Michael McElroy and Stephen Wofsy and their colleagues at Harvard has been important in understanding the impact of agricultural, industrial, and natural biospheric processes on atmospheric N_2O levels.

The possibility of human activities having a large impact on the stratospheric ozone layer was first raised in 1971 by Harold Johnston of the University of California at Berkeley. Johnston pointed out that the proposed fleet of U.S. supersonic transport (SST) aircraft would fly much higher in the stratosphere than conventional long range jets and that their exhausts would deposit high levels of NO and NO_2 at altitudes where O_3 destruction might be significant. A U.S. Department of Transportation funded research study pursued between 1972 and 1976 confirmed Johnston's concern about possible SST exhaust impacts and spurred much of the subsequent research on stratospheric chemistry. The concern over stratospheric ozone depletion was a minor contributor to the cancellation of the U.S. SST aircraft development program. The French and British did develop the Concorde, but poor economics have kept the fleet size far too small to be a significant source of stratospheric NO_x.

Interestingly, the National Aeronautics and Space Administration (NASA) has recently restarted a new High Speed Civil Transport (HSCT) research program, which includes a new generation of low NO_x aircraft engine concepts. Local researchers contributing heavily to NASA's evaluation of the potential HSCT fleet on stratospheric ozone include James Anderson and Stephen Wofsy with their colleagues at Harvard, Mario Molina and co-workers at M.I.T., Jose Rodrigues, Malcolm Ko, Dak Sze, et al. at Atmospheric and Environmental Research, Inc. (AER) and my colleagues Douglas Worsnop, Mark Zahniser, Richard Miake-Lye and Robert Brown at Aerodyne Research, Inc. (ARI).

While pursuing concerns about NO_x from SST exhausts during the early 1970's several research groups realized that solid rocket boosters, like the strap-on motors used with the space shuttle, deposit large amounts of chlorine (mostly as HCl) in the stratosphere. Richard Stolarski and Ralph Cicerone, then at the University of Michigan and Wofsy and McElroy at Harvard pointed out that chlorine, like NO and NO_2 could also catalytically destroy stratospheric odd oxygen, principally by reactions 9 and 10:

$$Cl + O_3 \rightarrow ClO + O_2 \quad 9)$$

$$ClO + O \rightarrow Cl + O_2 \quad 10)$$

$$\text{NET: } O_3 + O \rightarrow 2\,O_2 \quad 3)$$

HCl from the space shuttle (and more occasionally from large volcanoes) can be activated by reacting with OH radicals:

$$OH + HCl \rightarrow Cl + H_2O \quad 11)$$

which in turn are formed by many reactions, including $O(^1D)$ from reaction 1 reacting with either methane or water vapor.

However, we now know that, at current launch levels, the space shuttle and other similar rockets provide less than 1% of the chlorine deposited in the stratosphere, most of which comes from industrially produced halocarbon chemicals. The first publication, by Mario Molina, then at the University of California, Irvine, and F. Sherwood Rowland also of Irvine, detailing the role of man-made chlorine compounds in stratospheric ozone appeared in 1974. In 1987 the Northeastern Section presented Molina and Rowland with the first Esselen Award for Chemistry in the Public Interest for this work and their subsequent efforts to slow the release of chlorofluorocarbons. A handful of man-made industrial halocarbon compounds transport large amounts of chlorine to the stratosphere; these include chlorofluorocarbons 11 and 12, $CFCl_3$ and CF_2Cl_2, carbon tetrachloride, CCl_4, and methylchloroform, CH_3CCl_3, although many other man-made halocarbons also contribute. Until recently, CFC-11, CFC-12 and related chlorofluorocarbons were most widely known by the trademark Freon® used by duPont, a trademark made significantly less valuable by our developing understanding of atmospheric chemistry. Methylchloride, CH_3Cl, which has significant natural atmospheric source, is also an important stratospheric Cl source.

The list of stratospheric bad actors also includes the industrially produced bromine compounds CF_3Br and CF_2BrCl as well as CH_3Br which occurs naturally. Work initiated by McElroy and Wofsy at Harvard has led to the discovery of several very efficient methods by which bromine can also catalyze O_3 destruction, key reactions include:

$$Br + O_3 \rightarrow BrO + O_2 \quad 12)$$

$$BrO + O \rightarrow Br + O_2 \quad 13)$$

$$\rightarrow BrCl + O_2$$

$$BrO + ClO \rightarrow Br + Cl + O_2 \quad 14)$$

$$\rightarrow Br + OClO$$

$$BrCl + h\upsilon \rightarrow Br + Cl \quad 15)$$

These reactions, coupled with the fact the HBr is much less stable than HCl in the stratosphere, make Br a much more powerful ozone destruction catalyst than Cl. Fortunately, to date we have also deposited much less Br than Cl into the stratosphere.

Curiously enough, the NO_x identified by Crutzen and Johnston as a powerful destroyer of stratospheric ozone actually inhibits ozone destruction by Cl and Br. It accomplishes this by tying up ClO and BrO in relatively unreactive nitrate compounds:

$$ClO + NO_2 + M \rightarrow ClONO_2 + M \quad 16)$$

and,

$$BrO + NO_2 + M \rightarrow BrONO_2 + M \quad 17)$$

Under conditions of relatively high NO_X, chlorine nitrate and bromine nitrate formation significantly reduce the levels of ClO and BrO available to catalyze ozone destruction.

The homogeneous, gas phase stratospheric ozone chemistry represented by reactions 1-17 can be combined with 150-200 other atmospheric

(continued on page 14)

Historic Notes

Dr. Edward R. Atkinson, Amherst, MA

Conclusion of the biographies of recently deceased chemists and chemical engineers. The first part was in the November 1991 issue.

Joseph H. McCusker, 61, died on December 14, 1990. He was a 1950 graduate of King's College in Wilkes Barre, Pa. and then attended the University of Rhode Island and the Rhode Island School of Design where in 1958 he received the B.S. in textile chemistry. After Navy service in the Korean War he joined Cooley, Inc. in Pawtucket, R.I. and became senior vice president and technical director. He was a member of the Northeastern Section ACS, the Society of Plastics Engineers, ASTM, and AAAS. His name appears on 9 patents. As a 33-year resident of Raynham, Mass. he was active in town affairs and served as Town Moderator for 22 years.

Frederick G. Perry, 69, died on July 25, 1991 at his retirement home in Jackson, N.H. A native of Wellesley, he received the S.B. in chemical engineering from M.I.T. in 1945, then served as an Army captain in the Pacific theater. Following the war he received the master's degree from M.I.T. in 1947 and joined the professional staff at Arthur D. Little, Inc. He became involved in many programs including forest products, technical audits, and profitability audits. He served as president of the Boston section of the American Institute of Chemical Engineers (better known as the ichthyologists), as national vice president of the Swedenborgian Church, as director of the Wildcat Mountain Corp., and also was active in community affairs in Wayland.

E. Russell Pulsifier, 86, died on February 8, 1991. He was a Boston native who received degrees from Norwich University and the Harvard Business School. While a resident of Milton he was employed for 25 years as a chemist with Lever Brothers in Cambridge, and subsequently as an industrial engineer with Bird & Son in East Walpole. He also served as a substitute teacher in the Milton school system for 20 years. He was active in church and lodge affairs in Milton. At the time of his death he lived in retirement in Ocean Park, Maine.

Aram Haig Sevagian, 58, died on April 22, 1991. He was a Boston native who received the B.S. (1960) and M.S. (1962) degrees from Suffolk University. His professional career was as a teacher of physics and chemistry at Braintree High School. He also taught evening courses at Suffolk from 1959 to 1966 and coached the Braintree High School rifle team.

John Joseph Thornton, 85, died on April 17, 1991 at his home in Acton. Born in Concord, he received the B.S. degree from Boston College in 1927, then became head of the chem-

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Wanted – A Charismatic Chemist!

The Public Relations Committee is seeking a very special person – one who has an attractive personality, who can think well on the spot, does not swallow the microphone and would like to be promoted for possible interviews on news programs or talk shows to talk about chemistry and in particular about environmental chemistry.

One of our most important goals is to improve public understanding and awareness of chemistry. To this end, we shall be working with local radio and TV stations, in the hope of persuading them to include presentations by local chemists. If you are interested in this unpaid position or know of someone who might be highly suited, please let us know. You can contact Katie Stygall at (508) 372-7161. Please also let us know if you are interested in helping us to coordinate such activities. ◇

Dr. William E. Foye, Dr. Anne Baker Jenkins and guest Erica Bauer from Zurich

Dr. Myron Simon, Mrs. Luberoff and Dr. Benjamin J. Luberoff

(Photos by A. Fingland)

Board of Directors

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T. Light (representing ACS Employment Clearing House) and M. Simon (chair, Professional Relations Committee).

E. Hopkins indicated a need for knowledgeable chemists as a resource for environmental lawyers. C. Kolb offered to be a liaison in atmospheric chemistry. C. Kolb suggested T. Gilbert from Northeastern University for oceanography and people from Tufts University for ground water problems. ◇

Historic Notes

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istry department at Regis High School in New York. In 1946 he moved to become department head at DeSales College in Ohio. During this period he earned the Ph.D. from Fordham University in 1958. Before retiring in 1970 he was supervisor of research for 19 years at the U.S. Testing Co. in New Jersey.

Glenn Carber Williams, 76, died on July 2, 1991. He was an Iowa native with B.S. and M.S. degrees in chemical engineering from the University of Illinois and the Sc.D. from M.I.T. (1942). He was a member of the M.I.T. faculty from 1940 until his retirement in 1985. During World War II he headed the Institute's torpedo research group and later was director of research on fuels. He was an authority on missile propulsion and received the Navy Ordnance Development Award for his work in military propulsion systems. He also was president of the Combustion Institute. He was a member of Alpha Zeta of Alpha Chi Sigma. ◇

Stratospheric Ozone

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photochemical reactions in an atmospheric model to predict the effect of man-made chlorine and bromine compounds on stratospheric ozone levels. Local leaders in modeling activities include McElroy and Wofsy at Harvard; Sze, Ko and Rodrigues at AER and Ronald Prinn at M.I.T.

Model predictions made in the mid-1980's forecast significant depletion (5-10% by 2050) of stratospheric ozone levels if 1980 halocarbon atmospheric release rates were maintained. Motivated by these predictions, in September 1987 27 nations including the U.S. signed a treaty, the Montreal Protocol, to limit the production and atmospheric release of designated halocarbon compounds. This treaty, with its major impact on a significant portion of the world's chemical industry, is the first global legal agreement based on environmental chemistry and its implications. The treaty includes provisions for ongoing adjustments to the list of halocarbon (Cl and Br) compounds affected and the rate at which they are phased out of production. Most relevant leading U.S. and foreign chemical companies have responded with cooperation and have instituted intensive research and development programs aimed at identifying and efficiently producing substitutes for those compounds targeted by the treaty.

While the Montreal Protocol was being negotiated scientists first identified a new phenomenon, a massive seasonal destruction of ozone over Antarctica. That story, the underlying chemistry and its impact on observed and predicted ozone depletion levels, will be presented in Part II of this column. ◇

ACS News

Joseph E. Bunnett, University of California, Santa Cruz (emer.) will receive the Norris Award in Physical Organic Chemistry at the spring meeting in San Francisco, CA. His special contribution has been in nucleophilic aromatic substitution and his service as editor of *Accounts of Chemical Research* in which he has permitted discussions of conflicting interpretations of nonclassical cations. This is the only ACS award sponsored by a Local Section, our Northeastern Section. ◇

Can You Help?

by Katie Stygall

We hear so much about the plight of science education, about the lack of students entering science and the impact this will have on our future. During this summer, I encountered two situations that dramatically illustrate this problem–a problem that extends beyond science into education in general.

In June, I was fortunate enough to be helping in the making of a children's science video at the Kane Middle School in Lawrence. It was both an inspiring and a very depressing day. The children were inspiring–lively, curious and outspoken. Their school is a dismal environment, despite the obvious energy and enthusiasm of the teachers there. They have no science facilities–they have no money. Most of their windows are boarded up because they cannot replace them and the room I worked in had a huge hole in the wall. We had to make do with a poorly lit room because they cannot afford to replace light bulbs. It is an interesting statistic that just one mile away each child has $3000 more spent on his or her education per year. If you have old benches or laboratory equipment that you no longer need, or even funding, please let us know. Jim Steele, a colleague who coordinates the Kane School-Bradford College Partnership is participating in a project to make a science laboratory for the children at Kane–for those students who told me "they loved chemistry and wanted to do more."

I am also asking for help for a colleague in New Hampshire who is still using text books from 1968! If you could help fund this teacher or help find funding for new texts, please contact us. ◇

Calendar

For additional information, call:
Boston College – (617)552-3625
Boston University – (617)353-2537
Brandeis University – (617)736-2500
Clark University – (508)793-7116
Harvard University – (617)495-5333
MIT – (617)253-4080
Northeastern University – (617)437-2822
Tufts University (Chemistry, Medford Campus) – (617)381-3441
Tufts University (Chem. Eng., Medford Campus) – (617)381-3900
Tufts University Health Science Campus – (617)956-6867
UMass Dartmouth – (508)999-8232
University of New Hampshire – (603)862-1550

Monday, December 2

Professor Howard Brenner (MIT)
"Macrotransport Processes"
Tufts University (Chemical Eng., Medford Campus)
Audio Visual Rm, 4 Colby St. at 2:30 pm

Professor Anatol Zhabotinsky (National Scientific Ctr. for Hematology, Moscow)
"Dynamic Patterns in Biochemistry and Biophysics"
Brandeis University
Gerstenzang 122 at 4:00 pm

Professor Mike Kahn (Univ. of Illinois)
"Peptide Secondary Structure Mimetics: Probes for Biological Recognition"
Boston University
SCI 107, Science Ctr., Aud. at 4:00 pm

Prof. Jack Halpern (Univ. of Chicago)
"Some Mechanistic Aspects of Asymmetric Catalysts"
Harvard University
MB-23 at 4:15 pm

Tuesday, December 3

Dr. Wayne Hendrickson (Columbia University Physicians and Surgeons)
"Structure of CD4"
Tufts University Health Science Campus
Sackler Bldg, DeBlois Aud. at 4:00 pm

Thursday, December 5

Prof. Joanne Stubbe (MIT)
"Active Site Labelling of an α-Ketoglutarate Dioxygenase"
Boston College
New Chem. Bldg, Room 130 at 4:00 pm

Monday, December 9

Prof. Jack Halpern (Univ. of Chicago)
"Reactivity Patterns of Transition Metal Polyhydride Complexes"
Harvard University
MB-23 at 4:15 pm

Prof. Ernest Grunwald (Brandeis Univ.)
"Thermodynamic Tolerance Theorems"
Brandeis University
Gerstenzang 122 at 4:00 pm

Prof. Chifuru Noda (Univ. of N.H.)
"A Sound of Science: Listening to Molecules"
Clark University
Sackler Sci. Bldg, Rm N-104 at 4:00 pm

Tuesday, December 10

Dr. Ed Ziff (NYU Med. Sch./Howard Hughes Med. Inst.)
"Gene Regulation by Growth Factors"
Tufts University Health Science Campus
Sackler Bldg, DeBlois Aud. at 4:30 pm

Wednesday, December 11

Professor Peter Felker (UCLA)
"Structural Studies of Large, Weakly Bound Complexes and Clusters by Time-Domain Rotational Spectroscopy"
Harvard University
Fairchild Room 102 at 4:00 pm

Monday, December 16

Professor Eric Jacobsen (University of Illinois at Urbana-Champaign)
"Highly Enantioselective Epoxidation of Functionalized and Non-Functionalized Alkenes. Progress Toward Practical Catalytic Systems"
Harvard University
MB-23 at 4:15 pm

Tuesday, December 17

Prof. Eric Jacobsen (Univ. of Illinois)
Title TBA
Boston College
New Chemistry Bldg, Rm 127 at 4:00 pm

Wednesday, December 18

Professor Gilbert Nathanson (Univ. of Wisconsin)
"Bouncing Gases off Liquids: Molecular Beam Studies of Energy Transfer and Chemical Reactions at Liquid Surfaces"
Harvard University
Fairchild Room 102 at 4:00 pm

Notices for the Nucleus Calendar should be sent to:

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