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DEAN OF FACULTY

UNITED STATES AIR FORCE ACADEMY, COLORADO

Annual Research Progress Report No. 13

October 1978

COVERING PERIOD

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This is the sixth published Annual Research Progress Report; the editions previous to 1972 were published as Semi-Annual Progress Reports. Further information desired on any project may be obtained by writing to the department listed for the principal investigator, USAF Academy, Colorado 80840.

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C. Department of English

7. An Evaluation of Worldwide Endeavors in Genetic Engineering

Principal Investigator: Captain Robert H. Zellers, Department of Chemistry and Biological Sciences

Associate Investigators: Captain Martin D. Zahn and Captain Robert A. Peterson, Department of Chemistry and Biological Sciences

Sponsored by the Defense Intelligence Agency

This is an on-going evaluation that was begun in FY76. Current research in genetic engineering is being monitored through literature reviews, personal interviews, and attendance at appropriate symposia. Collection of information results in an analysis of trends and progress in genetic engineering efforts with emphasis on potential applications. A final report will be submitted in October 1978.

8. Fate of Herbicide Orange in Soils

Principal Investigators: Major William J. Cairney, Department of Chemistry and Biological Sciences; Captain Alvin L. Young, Occupational and Environmental Health Laboratory, Brooks AFB, TX; Dr. H. H. Cheng, and Mr. Joseph T. Majka, Department of Agronomy and Soils, Washington State University

Sponsored by Air Force Logistics Command

This cooperative field study is being conducted jointly by the Department of Chemistry and Biological Sciences, USAF Academy, and the Department of Agronomy and Soils, Washington State University. The study is attempting to assess breakdown products of both high and low concentrations of 2,4-D and 2,4,5-T n-butyl esters applied at rates comparable to spills in former AFLC Herbicide Storage Sites. A combination of ring and side chain labeled ^{14}C-2,4-D or ^{14}C-2,4,5-T n-butyl esters is being used in experiments which will provide data on probable degradation pathways, identification of metabolites, and rates of degradation. Field mini-lysimeters have been installed at the Washington State University Department of Agronomy and Soils Experiment Station. Corresponding microbial analysis is being conducted at the USAF Academy which will correlate levels of herbicide and herbicide metabolites with microorganism populations and diversity.

9. Analysis of TCDD in Biological Samples

Principal Investigators: Major William J. Cairney, Department of Chemistry and Biological Sciences; Captain Alvin L. Young, Occupational and Environmental Health Laboratory, Brooks AFB, TX; Dr. Michael Gross, Department of Chemistry, University of Nebraska

Sponsored by Air Force Logistics Command

In support of the Air Force Logistics Command project on Disposition of Herbicide Orange, the Department of Chemistry and Biological Sciences has been conducting extensive research on the fate of TCDD (2,3,7,8-tetrachlorodibenzo-p-dioxin, a contaminant of Herbicide Orange) in the environment. Since 1975, personnel of this department have been collecting soil and biological samples from areas exposed to Herbicide Orange and TCDD. One hundred samples have been collected, placed separately in glass jars and maintained in a freezer pending analysis of TCDD at parts per trillion level (ppt). The analysis of TCDD in biological systems requires a complex extraction and cleanup system in addition to highly sophisticated instrumentation. No Air Force laboratory currently has this capability. Two universities currently do have, but only one (The University of Nebraska) is available. The University of Nebraska is currently under contract to the Department of Chemistry and Biological Sciences, USAF Academy, to analyze these biologicals. A technical report is forthcoming which will summarize all of our past data on the fate of TCDD in biological systems and incorporate the results from the University of Nebraska analyses.

10. Chemical and Microbiological Monitoring of Sites Previously Used for Storage of Military Herbicides

Principal Investigators: Major William J. Cairney, Department of Chemistry and Biological Sciences; Captain Alvin L. Young, Occupational and Environmental Health Laboratory, Brooks AFB, TX; Dr. B. Mason Hughes, Flammability Research Center, University of Utah

Sponsored by Air Force Logistics Command

This study is part of an overall effort by Air Force Logistics Command to reclaim, decontaminate, and restore areas formerly used for the storage of Military Herbicides. The two former storage areas are respectively located at the Naval Construction Battalion Center, Gulfport, Mississippi, and on Johnston Atoll in the Pacific Ocean. The initial phase of decontamination is chemical and microbiological site monitoring, Forty-three sites have been selected at each location for analysis. Test sites were selected on the basis of heavy herbicide spill and heavy herbicide odor (designated H/H), light herbicide spill and odor (designated L/L) and no detectable spill or odor (designated 0/0). In addition controls were selected from locations adjacent to former storage areas which had never received any herbicide. Testing of these sites for 2,4-D, 2,4,5-T, and associated dioxins is in progress and will continue over a two year (or more) period. Levels and diversity of soil microflora are currently being determined and will be correlated with levels of herbicide to assess the possible effects of herbicide on microflora and possibly provide data on the role of microorganisms in herbicide biodegradation. The Flammability

Research Center at the University of Utah is uniquely suited to provide Mass Spectrometric chemical analytical support. Dr. Mason Hughes has personally developed all of the protocol being used and is able to analyze for 2,4-D, 2,4,5-T and breakdown products at a resolution unattainable anywhere else in the world. In addition, he has assembled an automated, computer-linked system which provides rapid results. Present experimental results indicate that high levels of herbicide and dioxin are present in storage site spills. Microbial studies have shown that application of 2,4-D and 2,4,5-T at massive rates (5000-40,000 ppm) not only did not sterilize the soil, but actually stimulated the growth of some soil micro-organisms. This next set of samples (programmed for October-November 1978) will begin to yield data on breakdown rates in the two storage sites.

11. The Effect of Hyperbaric Oxygen on Mycotic Disease Agents

Principal Investigator: Major William J. Cairney, Department of Chemistry and Biological Sciences

This research is presently unsponsored. The project attempts to determine oxygen toxicity limits for selected mycotic disease agents in an effort to find expanded application for the USAF Compression Chamber Treatment Facilities (i.e., Hyperbaric Chambers). Students in English 330 and Bio Sci 499 are programmed to do literature review and experimental studies on the project. Preliminary results indicate that a number of mycotic disease agents have oxygen toxicity limits within levels readily tolerated by susceptible humans and animals.

Publication

Cairney, W. J. 1978. Effect of hyperbaric oxygen on certain growth features of Candida albicans. Aviat. Space Environ. Med. 49(8):956-958.

12. Chemical Structure/Bonding Decomposition Relationships

Principal Investigator: Major Joel W. Beckmann, Department of Chemistry and Biological Sciences

Associate Investigators: Captain R. Martin Guidry, Captain Larry P. Davis, Lt John S. Wilkes, Frank J. Seiler Research Laboratory; ClC Robert Wheelock, ClC Craig Gilbert, Department of Chemistry and Biological Sciences

Sponsored by the Frank J. Seiler Research Laboratory, Air Force Systems Command (AFSC)

Two areas of study were conducted as Chemistry 499 projects under the supervision of Major Beckmann.

a. The objectives of C1C Gilbert's project were the isolation and identification of the catalytic precursor to the thermal decomposition of Trinitrotoluene (TNT). This project resulted in identification of the catalytic precursor as 4,6-dinitroanthranil. Also, the formation of 4,6-dinitroanthranil fits nicely into a mechanism for TNT thermal decomposition proposed by Capt Shackelford.

b. The objective of C1C Wheelock's project was to investigate the decomposition mechanism of hexanitrostilbene (HNS) via the kinetic isotope effect expected from the replacement of the allytic protons with deuteriums. This effect is used to help determine whether the C-H/C-D bond breakage in HNS and similar compounds such as TNT is rate determining. The kinetic results obtained were inconclusive; however, they provided two major improvements in the current experimental procedure; computer data acquisition and a variation in the synthetic technique for deuterated HNS.

13. Citizen's Workshop Program on Energy and the Environment

Principal Investigator: Captain Ronald E. Channell, Department of Chemistry and Biological Sciences

Associate Investigators: Lt Colonel Hugh T. Bainter, Major John H. Birkner, Major James R. Wright, Captain Elroy A. Flom, Captain John A. Klube, Captain James T. Norelius, Captain Donald A. Potter, Captain Ronald E. Watras, Department of Chemistry and Biological Sciences; Dr. Phil Kearney, Colorado State University, Fort Collins, CO; Dr. Mike Lowenstein, Navarro College, Corsicana, TX; Mr. Roger Howard, West Junior High School, Grand Junction, CO

Sponsored by the Department of Energy through Interagency Agreement

Citizen's Workshops are educational programs that give citizens an opportunity to learn more about energy and environmental needs and problems. Participants get a chance to try their hand at solving some of the energy-environment problems facing the nation today by using an Energy-Environment Simulator.

The Energy-Environment Simulator is a specially designed analog computer that simulates real-world conditions. Energy resources, energy demands, and environmental effects are programmed into the electronic device. As the clock speeds time by at the rate of a century a minute, participants must make decisions about the allocation of energy resources. They do this by operating controls on remote panels in response to the changing situation.