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CONTENTS

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Global Environment Monitoring for Ecosystem Health and Human Well Being — Report from a Round Table Discussion on International Collaborative Studies

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Under the auspices of the United Nations Environment Programme (UNEP), the International Program on Plant Bioassays (IPPB) conducted an international monitoring project on genotoxic effects of air, water and soil pollutants. Results of 20 laboratories from 14 different countries involved in this program were compiled in 26 papers and are in press for publication in a special issue of Mutation Research. The Pan African Environmental Mutagen Societies (PAEMS) 1999 meeting at Harare, Zimbabwe chose this program as an example of international collaborative studies and the program was included in the Round Table Discussion. The IPPB/UNEP emphasizes the use of simple, quick and inexpensive plant bioassays to detect the genotoxicity of pollutants to protect ecosystem health and human well being. The ultimate goals are to establish a database on the environmental status of different areas of the world; and to use plant bioassays as demonstrative tools of harmful effects of pollution to carry out environmental education at the grassroots level. Among the symposium speeches and scientific reports in this meeting, infectious diseases and mycotoxins were emphasized. Disease prevention, reduction of pollution, ecosystem protection and education for the general public were the major concerns of this meeting. International collaborative studies in all fields of environmental sciences were encouraged.

Keywords: Environment, pollution, monitoring, *in situ, Tradescantia, Vicia*

Introduction

'Affluent Society is Effluent Society' was one of the profound slogans uttered at the first conference on environmental pollution and ecological problems held at Argonne National Laboratory, USA in 1970. The awareness of the environmental problem ties closely to the life style of modern society. The mission of the early environmental movement was clearly focused on reduction of pollution by changing life style. Around the same time, the Environmental Mutagen Society (EMS) was established by a handful of scientists at Oak Ridge National Laboratory. The aims of the early years of EMS were to detect environmental agents that cause genetic damage, reduce the source of pollutants, and above all to change life style. The

latter, changing of life style, has long been ignored. Genetic damage was specifically emphasized because of its far reaching effects on future generations. In 1980, US EPA initiated the Genetic Toxicology (Gene-Tox, 1980) program, and mobilized scientists in many countries to conducted a thorough literature survey on the environmental agents tested by biological systems. Gene-Tox established the initial data base which was published in a series of reports in Mutation Research (Grant, 1982, Ma, 1982a, 1982b). Plant bioassays were one of the 26 groups included in the Gene-Tox program. Plant systems have been known as highly sensitive tests of pollutants (de Serres, 1992) owing to the fact that plant tissues and their germ cells are less protected than those of the animal tissues and reproductive organs. Many well known mutagens and clastogens were tested using plant bioassays and linear dose responses with a wide range of dose tolerance, were established for X-rays, ethylene dibromide, formaldehyde fumes, diesel exhaust fumes, EMS, primaquine, cyclohexamide, neutron and gamma rays. In the early 1980s, four plant bioassays, that is, the *Vicia/Allium* root chromosome aberration(AVR-CA), the *Tradescantia* - Stamen Hair Mutation (Trad-SHM), the *Tradscantia* micronucleus (Trad-MCN), and *Arabidopsis* embryo mutation (Arb-EM) were selected by the International Program on Chemical Safety as *in situ* monitoring and as laboratory screening tests. A validation project was initiated in 1985 to determine the efficiency and reliability of these four bioassays. Results of the validation studies were reported in 1991 (St. Petersburg, Russia) and published in the second special issue in Mutation Research in 1994 (de Serres,1994). The validation study found all the four assays were efficient for screening mutagens and clastogens. With the exception of the *Arabidopsis* assays, the other three are also specially suitable for *in situ* monitoring in addition to the mutagen screening. All these three genotoxicity detectors have long been used for genetic and cytogenetic studies. *Tradescantia* microspore chromosomes have been used to establish the standard patterns of chromosome/chromatid aberrations since the early 1930s. The late Alexander Hollaender used *Tradescantia* to study the clastogenic effects of X-rays (Swanson and Hollaender, 1946). *Tradescantia* SHM test has a substantial data base on ionizing radiation and chemical mutagens since the early 1960s (Underbrink *et al.*,1973) Trad-MCN was developed in 1978 (Ma *et al.*,). The AVR-CA studies started as early as *Drosophila* and maize in cytogenetic studies.

Both Trad-MCN and AVR-CA assays are truly short term tests which can yield test results within 24 to 48 hours while Trad-SHM assay requires a 7 to 11 day recovery time. All these bioassays do not require expensive equipment or reagents and the testing procedures are very simple. They are suitable for elementary and secondary school classroom experimentation and yet they are efficient and reliable for college and graduate level research. Current reviews (Stachetti-Rodrigues *et al.*, 1997, Grant, 1998) plus the early Gene-tox data base (Grant 1982, Ma, 1982a, 1982b), have more than 500 publications.

Materials and Methods

The treatment procedure in the Trad-MCN and SHM assays include the exposure of the young inflorescence from the plant cuttings to either gaseous or liquid agents in the laboratory setting or *in situ* for the field studies, for 6 to 12 hours. Data collection was done by scoring the frequencies of MCN in the slides prepared from the early tetrad stage of the microspore mother cell meiosis for (the Trad-MCN assay) and scoring the pink mutation events in the mature full bloom flowers in (the Trad-SHM assay). In the AVR-CA tests, newly germinated roots (1 to 2 cm in length) can be exposed in a sample solution prepared in the laboratory or collected from field sites, or exposed *in situ* directly at the site with a floating device (6 to 12 hours). Chromosome aberration frequencies can be obtained from the slides of the root tips prepared by aceto-carmine or orcein squash method. An improved *Allium/Vicia* root-micronucleus test (Ma, *et al.*, 1995) is a simplified technique for clastogenicity studies.

Results

Results of the follow-up study of the hands-on workshop conducted in China in 1995 were published in the third special issue of Mutation Research (Grant *et al.*, 1999). This is the first attempt of a global environment monitoring program with participants from 14 different countries in four continents under the auspices of the United Nations Environment Programme (UNEP).

Discussion

In the course of the PAEMS'99 meeting, mycotoxin, mutagenic contents in foods and beverages, viral and microbial agents that cause diseases in human populations were major concerns as expressed by participants. It was a well designed meeting that focussed on the urgent problems of African countries. In a broad sense, those unwanted agents that affect human health should also be considered as environmental pollutants. A few presentations dealt with air, water and soil pollutants. The honorable Minister of Health and Child Welfare of Zimbabwe, Dr. Timothy Stamps, mentioned in his opening address that prevention of disease is more important than the cure. The international program on environmental monitoring extend his philosophy to emphasize the detection and abatement of pollutants as a preventative measure rather than spend most of our resources on the cure of pollution-related illnesses. Ecosystem health should be the primary concern for the protction and promotion of human health (Epstein, 1996; Rowe, 1996; Gopalan, 1999). The term 'ecosystem' was mentioned by Dr. Christopher Schonwalder of NIEHS as a major programme of the institute. Under the auspices of UNEP, IPPB presented a poster on Ecosystem Health and Human Well Being. This presentation emphasized the use of simple, quick and inexpensive plant

bioassays to detect the genotoxic effects of pollutants and to establish a database of the environmental status of different areas of world. By using these plant bioassays as the demonstrative tools for environmental education to the general public. As a matter of fact, about 20 years ago when Acquired Immune Deficiency Syndrome (AIDS) was first known to the world, the immediate idea for the prevention of AIDS pandemic was 'education'. Now, 20 years later, in spite of the advancement made on the potential cure and possible immunization, the most promising approach for prevention of AIDS is still 'education'. By the same token, the most effective way for prevention, reduction of pollution is education at the early age and in all different social strata with special emphasis on the holistic education that is rooted in ethics and on family values. Dr. Jerry Rice of the International Agency of Research on Cancer touched on the education and ethics issues in his talk.. As we know, ethics or morality is not something that can be taught but has to be nurtured in the family, schools and social surroundings (Gopalan, 1999). By using these simple, straight-forward plant bioassys to detect the genetic toxicity of water, air and soil, we may be able to demonstrate the ill-effects of pollution to the general public and to protect the ecosystem and human health through environmental education .

A question was asked as to 'whether or not there have been any attempts made to correlate the plant bioassay results to human health?' The answer is that epidemiological survey and Trad-MCN studies has been carried out side-by-side by the Department of Pathology, School of Medicine, University of Sao Paulo, Brazil. A similar program has been carried out in the School of Public Health of the University of Brescia, Italy. These parallel studies may shed some light on environmental conditions and human health. In a recent UNEP publication, (UNEP/WHO, 1995) chemical monitoring data were correlated to human illness in China. Parallel studies using mouse micronucleus tests and Trad-MCN assay on drinking water (Ma *et al.*, 1987) were carried out to compare the efficiency of the plant and animal systems. Cross reference with the test results of human lymphocyte culture and epidemiological surveys, results of plant bioassays could be correlated with human health indices. Results of many heavy metals, PAHs, halogenated compounds that have been tested with plant bioassays could be compared with the results obtained with human lymphocyte micronucleus studies to establish the correlation between human cell culture and plant cell systems.

Among 14 countries which are the members of IPPB at the present time, three institutions are in the field of medicine, cancer research or public health. More and more health related institutions adopt plant bioassays because of the realization that pollution related illnesses ought to be prevented by early detection and remediation of source of pollutants. .

Plant bioassays can be applied directly to the polluted water or air without condensation, filtration or sterilization that are required in microbial tests. Plant bioassays can be applied to complex mixtures of gaseous or liquid forms under the true-to-life environmental conditions. Since pollutants in the environment are

almost always in mixture forms, plant tests can yield more relevant results than most animal test results of individual agents, one at a time. At the present time, institutions from more than 40 different countries have expressed interest in joining this International Collaborative Study to safeguard the ecosystem and human health. Participation of African countries in this program would be mutually beneficial to the peoples of that continent and to the rest of the world.

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