ENVIRONMENTAL BIOPOLLUTION

PROCEEDINGS OF THE
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Edited by
S. T. TILAK

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PREFACE

The ready response of many aerobiologists throughout India to our idea of holding of National Conference of the Indian Aerobiological Society and the energetic enthusiasum of my students'' aerobiology group of Marathwada '' in organising such a useful conference effectively culminated in the First National Conference. However with deep pain and sorrow I am reminded of the unacademic attitude and activities of some who made every attempt to spoil the spirit of the conference by creating several obstructions and raising odd problems beyond our imagination and tried to make our attempts futile. It was the united active co-operation of all my students who firmly believed in their efforts and saw the grand success of the conference.

The objectives we set ourselves during the meetings of Aerobiology meetings, both inside and outside the meetings, were the promotion of aerobiology in India. It is my impression that most of the objectives were achieved. The main purpose of such meetings and conferences must be to bring into contact the aerobiologists and those who have a need for the knowledge of aerobiology. This too has been achieved and many useful exchange of information and opinion took place, during the sessions and can confidently be expected in future. The conference thus provided a very useful forum for aerobiologists.

Generous funding for the conference by the University Grants Commission, Indian Council of Medical Research, Indian Council of Agricultural Research, the then Chief Minister of Maharashtra Hon. A. R. Antuley, Department of Education Government of Maharashtra, is gratefully acknowledged. The department of Science and Technology extended financial help to meet the part of the expenses for printing of the proceedings.

We were fortunate in having Dr. V. S. Khuspe, Vice-Chancellor of Marathwada Agriculture University, Parbhani to inaugrate the conference. Dr. Siwert Nilsson President International Association, Stockholm, Sweden encouraged on all occasions by his presence here.

We are in great debt and gratitude for ready and unstinted support throughout the conference by our former Vice-Chancellor Dr. B. R. Bhonsale and to Dr. A. M. Vare, Dean, Medical College, Aurangabad for his help and co-operation in organising medical session in the premises of Govt. Medical College. Our Registrar Dr. B. M. Patodekar deserves special thanks for his help and encouragement.

Our special thanks are due to Dr. Arvind Lonkar, Dr. B. N. Bapat, Dr. S. Nagarajan, Dr. Sunirmal Chanda for key note addresses and Prof. M. Babu, Teacher Fellow of our Aerobiology Laboratory for his constant help throughout the Conference, and to Shri R. M. Naik, Vivek Mudranalaya, Aurangabad for speedy printing.

(S. T. TILAK)
Editor

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Environmental Biopollution

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1. Introduction

I consider it is a great privilege for me to be able to come to the Marathwada University, a great seat of learning, which patronizes the well known Aerobiology Laboratory under the inspiring leadership of Prof. Tilak, who is also the Chairman of the Organizing Committee of this Conference.

2. World concern for environmental pollution

The growing concern for protection of the environment has rapidly developed on a worldwide scale, during the past decade in particular, resulting into the United Nation Conference on Human Environment held in 1972 at Stockholm. The awareness on the pollution of environment induced establishment and attention of several agencies like the United Nations Environmental Programme (UNEP), United Nations Organization on 'Habitat', World Health Organization (WHO), World Life Organization, and a host other bodies those which are dealing with the environmental problems on a global scale. The observation of World Environment Day in June every year is probably a significant sign of people's concern to keep the environment free from pollution.

3 Definition of pollution

Air pollution is the presence in the atmosphere of one or many contaminants in such quantities, characteristics, and duration as to make them actually or potentially

injurious to human, plant or animal life or which interfere with the normal enjoyment of life. This is particularly important in developing countries, e. g. India, many of which are undergoing rapid growth in their economies, especially through the increasing growth of population, urbanization and industrialization.

4 Nature and character of atmospheric pollutants

The occurrence of suspended particulates creates directly toxic effects or aggravation of the effects of gaseous pollutants, aggravation of upper tract respiratory allergy, asthma or other respiratory or cardiorespiratory symptoms, increased cough and chest discomfort and eventually increased mortality.

Dealing with aerobiological research in terms of environmental biopollution we are mainly concerned with settleable particles and aerosols.

5 Research in India on Aerobiology in relation to medicine and plant pathology

The realisation of the importance of Cunningham's(1873) work came after a gap of about 100 years in this country when the planners and scientists felt that the threatened environment needed to be investigated under a wider prospective; i. e. the atmospheric bioparticles are to be indentified, watched and monitered at regular and frequent intervals all over the country.

In view of significant contributions made by the Indian aerobiologists, a few workshops on the progress of aerobiology were held in different places in India in 1980. One of these was in the Bose Institute, Calcutta, which was held under the joint sponsorship of the Bose Institute and the British Council, where delegates assembled from different institutions and universities from all over India to attend the workshop for a better orientation of their future research programmes in various aspects of aerobiology, both theoretical and practical.

6 Foundation of Indian Aerobiological Society

After the final session of the workshop i. e. on 31 January 1980, the Indian aerobiologists met exclusively to discuss the future of Indian aerobiology in presence of Dr. Siwert Nilsson, President, International Association for Aerobiology, where it was unanimously decided to establish an All India Society to deal with matters pertaining to aerobiology and the name of the body was proposed to be Indian Aerobiological Society (IAS) where twelve office bearers were elected in the form of an Executive Council.

It was our great pleasure to get an invitation from Prof. S. T. Tilak of the Aerobiology Laboratory, Marathwada University, Aurangabad, who incidentally is the Vice-President of the Indian Aerobiological Society, to hold the First National Conference on " Environmental Biopollution " under the aegis of the IAS.

7 Role of bioparticles in atmospheric pollution

Pollen and spores are the major organic constituents of the atmosphers. The

harmful effect caused by their presence in the atmosphere has induced scientists to take up several lines of research programme in India, namely,

1. Production and dispersal biology of pollen grains and fungal spores.
2. Floristic survey and pollination ecology.
3. Analysis of pollen and fungal spore antigens and study their clinical significance.
4. Biochemical aspect of pollen/spore allergens.
5. Storage microbiology.
6. Aerobiology and plant pathology in relation to microbial pollution and their relevance to diseases of crop plants in field and diurnal storage.
7. Handling of occupational and airborne diseases.
8. Techniques pertaining to trapping of airborne particles.

The magnitude of the problem related to various types of allergic diseases in India is rather alarming. Morbidity surveys in Delhi and Patna have revealed that more than one percent of the population of this country (about 6 million) suffer from bronchial asthma. Another three to four percent suffer from periodic allergic colds. It is estimated that more than ten percent of the population of India suffer from one or the other allergic disorders, e. g. nasal, bronchial, dermal, gastro-intestinal, etc.

A new field has emerged in aerobiology which relates to bio-deterioration of stored material, including food and books in library where airborne organisms and environmental factors interact. Analysis of indoor microbial population with an ecological approach of biodeterioration has proved to be useful in relation to prevention of disease. The data of the intramural research are to be correlated with outdoor monitoring which have close relevance with source of organisms in terms of air pollutants both in and outside closed system.

8 Aerobiological monitoring

In a vast country like India monitoring of the atmosphere requires the establishment of an air monitoring network to supply the aerometric data necessary to support air pollution prevention, control and abatement activities. The very nature of the environmental biopollution problem varies widely from area to area, depending upon the characteristics of meteorology, topography, source points, etc. To determine the potentiallty of the incidence of airborne bioparticles, periodical data of quantity, quality, distributional pattern and period, dispersal mechanism, rate of production, and as already mentioned, source, etc. are to be recorded. In this context, in India we need detailed and quantitative methods to understand the pattern of dispersal, transport and deposition processes for given particles under determined conditions. Study of the life histories of most of the organisms with which we are concerned in different parts of India is also necessary.

In this country we have no integrated and coordinated national programme yet. It is now time that we think and plan to pull all the resources for aerobiol-

ogical monitoring, prediction and warning into a scheme of optimum value to the human and plant populations in terms of medicine and plant pathology. The system, when effective, might contribute more directly and more immediately to the benefits of people.

9 Recommendations for the abatement of environmental biopollution

After the Varanasi Science Congress a special Environment Committee recommended several measurers out of which the following points are pertinent to aerobiological research in India :

1. Government agencies and academies should institute special incentives of awards for successful viable antipollution researches.
2. Collaborative programmes and researches should be initiated for the control of air and water pollution with the other industrialized countries, and an appraisal be made of the measures adopted by them.
3. Planting of trees properly suited to the climate but not causing aerobiological hazards is to be organized as a routine measure through Forest Departments and Educational Institutions. Aerobiological data should be made available specially for plants having allergenic spores and pollen.
4. Aerobiological centres should be established in different parts of India including the cosmopolitan cities for monitoring and resarch on airborne spores and pollen.
5. Encouragement should be provided for development of use of indigenous instruments to monitor local pollutants In this context extensive use should be made of satelite and space technology to monitor environmental pollution.

10 Conclusion

Finally it may be stated that aerobiology is an integration of medical and agricultural aspects with corresponding possibilities of recording pests and diseases A monitoring network should be established to predict and control environmental changes induced by meteorological conditions and by infestation of biopollutants; to determine possible trends of harmful effect and to develop a warning system related to preset criteria including predictions of the environmental consequences; and finally activity in the total system in the form of action designed to avoid environmental deterioration. In other words, a large consolidated effort will have to be invested in aerobiological research and monitoring as an aid to continuing censuses of many plant, animal and microbial populations and simultaneous measurements of environmental changes.

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Aerobiology, Climatology and satellite monitoring in relation to cereal rusts

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Epidemic is a polycyclic process. Naturally spore infection, sporulation, dispersal and deposition occur continuously during this period. Spread of plant pathogens are of two kinds one happening within the boundary layer and the other being transported from higher altitudes. Cereal rusts are transported by upper layer currents over long distances and hence, application of aerobiological concepts and principles along with that of meteorology have come to stay in analysing cereal rusts epidemics.

Late Prof. Dr. K. C. Mehta, initiated cereal rust work in India, and carried out extensive aerobiological studies. Present investigations show that stem rust of wheat *(Puccinia graminis tritici)* mainly survives in the group of south Indian hills, and gets transported every year to north and central India due to turbulance created by tropical cyclone. November cyclones in the Bay of Bengal enable efficient spore take- off from Nilgiris, transportation and eventual wash-down over central India. This integrated approach of aerobiology and meteorology led to the formulations of certain synoptic rules called the Indian Stem Rust Rules, based on which stem rust appearance can be predicted. Cyclones, the macro weather system, can be monitored by weather satellites, and the area where primary infection would appear can be predicted about a month prior to the appearance of the disease.

Brown rust of wheat *(Puccinia recondita tritici)* occurs all over the country and its epidemiology from South to Central India is identical to that of stem rust. In the Indo-Gangetic plain oversummering inoculum from Nepal spreads to parts of East UP and Bihar due to mid low level currents and disease appear around Christmas to mid January. In addition, primary infections also appear along the foot hills of North-Western India to a distance of 60 km. mainly due to the katabatic winds. It has been found that Eastern India acts as the breeding ground for transportation of brown rust inoculum to parts of North-Western India along with Western Disturbances that cause winter rains. The rain depos ted the inoculum that is numerically more than the local inoculum helps build-up an epidmic by March, which is completed by mid-April.

Yellow rust *(Pucci ia striiformis)* is a close door problem of North-Western India and its nature and recurrence is also linked up with the Western Disturbances. The number of rainy days has been found to have a direct bearing on the disease development over Indo-Gangetic plain. A bio-climatic approach has been developed to predict the disease.

An epidemic is a pehnomenon that occurs over a large area. Its intensity and magnitude could be monitored from resources satellite such as the Landsat. Primary investigation conducted during 1978 show that the healthy crop of India could be differentiated from the diseased crop of Pakistan. As India has an ambitious plan to launch its own resource satellite, developing this monitoring technology would be in the long run beneficial for better management of our crop resources

The boundaries between disciplines are getting more and more inter-mingled, and unless various scientists work together, it may not be possible to make any break through in research. In developing a plant protection system interaction of Aerobiologists, Pathologists and Physicists would be necessary, as is evident from that of wheat.

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Glimpses From Past and Current Aerobiology

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The term *aerobiology* was coined already in the 1930's to embrace studies of fungus spores, pollen grains and bacteria in the atmosphere. The scope of aerobiology has later been widened to include various other biological particulates *(air spora)* e. g. viruses, algae, fungi, lichen fragments (soredia), spores, pollen, seeds, plant propagules protozoa (cysts), minute insects, spiders and so forth. Abiotic particulates or gases affecting living organisms are currently included in the concept of aerobiology.

The size of air spora varies from ca. 0. 02 um (or less) in viruses to 100 um or several centimeters (Edmonds 1979).

Some insects naturally fall within the definition of aerobiology (passively airborne) while other groups, birds, bats and, definitely flying humans must be excluded. Airborne biological particles are also named *aeroplankton* to denote the passive dispersal. Gases containing floating dusty particulates are called *aerosols.*

The *aerobiological process* (Frinking & Risdijk 1977) comprises five main steps, source, release, flight, deposition and impact. Each step is affected by environmental factors.

Aerobiology is a typical interdisciplinary subject with numerous aspects and characterized by continuous interrelations between the biological components and

their physical and chemical environment. For practical purpose aerobiology can be divided into *intramural* (indoors) and *extramural* (outdoors) aerobiology.

SOME AIR SPORA

Spores etc.

Spores or spore stages occur both in the plant and animal kingdom. Examples of fungal spores (fungi) are *Mucor, Aspergillus, Penicillium, Heliomyces, Alternaria, Helminthosporium, Cladosporium, Claviceps, Venturia, Erysiphe, Epicoccum,* and spores of Basidiomycetes (*Russula, Lactarius, Armillaria, Sporobolomyces, Merulius, Tilletia, Puccinia*). Among the air spora components are furthermore fern spores (*Lycopodium* and *Pteridum*), airborne algae (e. g., *Glococapsa*) and protozoan taxa, e. g., *Tetramitus* and *Thecamoeba* (Gregory 1973).

Pollen

Some common pollen types from Northern Europe and North America are : *Betula, Pinus, Phleum* (Poaceae) ragweed (*Ambrosia artemisifolia*). Some pollen may carry air pollutants (lead, sulphur).

THE AIR SPORA ENVIRONMENT

General meteorology

The atmosphere can be subdivided into two main layers, the troposphere and the stratosphere, separated by the socalled tropopause (Gregory 1973). The Troposphere is about 10 km high and is generally characterized by changes of pressure and a decrease in temperature with increasing height. The troposphere is of our particular concern. Near the ground there is a *laminar boundary layer* of some millimeters or centimeters thickness which is still and windless in principle. Above this layer there is a *turbulent boundary layer* characterized by mechanical or frictional turbulence. On top of that latter layer up to a height of 1 km there is an outer *frictional turbulence layer*. A *convection layer* extends up to 10 km. Turbulence here is very rare. The tropopause is the zone where most jet planes are flying.

The thickness of the various layers differs between day and night. During a sunny day parcels of warm air are lifted upwards and cumulus-clouds are being formed at the top of the convection layer. During a still and clear night no clouds are formed and the air spora at ground level may be lifted up very high.

If the temperature *increases* upwards instead of decreasing a situation named inversion may happen. The inversions are supressing vertical air movements and air including pollutants may thus be enclosed at lower levels.

Atmospheric circulation

Due to solar heating and friction phenomena, rotation of earth etc. air masses, cyclones (low-pressures) and anticyclones (high-pressures), with fronts are formed.

Air currents at different levels, usually over long distances are called *trajectories*.

Air pollution

Pure or normal air mainly consists of a mixture of nitrogen (c. 78%), oxygen (c. 21%), water vapour, argon and many other gases in minute proportions. *Air pollutants* are added to the atmosphere prevailingly through human activities. Some of the pollutants, particulats or gases are causing damage to man, plants and animals. Some people involve pollen and spores in the pollution concept which however, is better restricted to chemical agents. Among the chemical, particulate pollutants, soot and various toxic metals (lead, mercury, asbest, cadmium) may be mentioned; of gases carbon monoxide (CO), nitrates, sulfur dioxide (SO_2) and so forth.

The type of environment for air spora and all living organisms is determined more or less exclusively by humans who subseqently have the utmost respons bility for maintaining an acceptable quality of the air we breathe.

THE AEROBIOLOGICAL PROCESS

The air spora and abiotic particulates are all subject to the same laws and the previously mentioned five steps are common denominators.

The source

Three types of sources may be distinguished, *point source*, *linear source*, and *area source*. A forest, lake or sea-surface is an example of the latter type while an anther, or ascus may serve as a point source. Within the source concept production and liberation of air spora, or emission of abiotic substances are included. It has been estimated that one single flower (two anthers) of *Betula* may contain ca. 20.000 pollen grains and one catkin ca. 5 million (Pohl 1937). Recent studies confirm these figures (20.000 ± 280), the number of flowers per catkin is around 200. For further studies the number of catkins per tree will be added to the calculations in order to get an adequate measure of the pollen production in a whole population of *Betula*. Fungi produce multiple figures of spores, e. g. 7 trillions in giant puffball, *(Lycoperdon giganteum)* (Buller 1909). *Picea abies* forests in southern Sweden produce altogether 75.000 tons pollen per year.

Adaptions facilitating discharge and air dispersal show more diversity in the fungi than in any other group. There are both passive and active mechanisms. Different ways of liberation are well described by e. g. Ingold (1971), Gregory and others. Moss spores of *Cephalozia* are liberated through hygroscopic movements of elaters. In *Sphagnum* the air below the spore mass in the capsule eventually becomes compressed and the spores are shot away more than 10 centimeters (DFG 1971). Pollen grains of anemophilous plants, like grasses, are shed by means of the wind. (Marilaun 1895, Gregory 1973). Many species have a well-defined diurnal rhythm as to anthesis and liberation. Temperature, light, relative humidity may influence the anthesis of grasses while emission appears to be more of a mechanical process (Liem & Groot 1973).