B I O - D A T A

Name	: Dr. N.V. Joshi
Designation	: Mathematical Programmer
Department	: Centre for Theoretical Studies
Age and Date of birth	: 31 years 14.12.1951
Date of appointment	: 1.12.1978 - Mathematical Programmer 5 Years contract (Confirmed)
Contract ended on	: 30.11.1983 Continued in the post on existing terms and conditions until further orders
Qualification	: M.Sc. (X-Ray Crystallography) (Bombay) - 1974 - II Class Ph.D. (I.I.Sc.) 1980
Present basic pay and grade	: Rs.675/- p.m. in the grade Rs.550-25-750-EB.30-900 w.e.f. 1.12.1983
Total emoluments	: Rs.1,669.40 p.m.

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Name of the staff member	:	NIRANJAN VASUDEO JOSHI
Designation	:	~~Mathematical Programmer~~ Lecturer
Department	:	Centre for Theoretical Studies
Age and date of birth	:	~~32 years~~, 14th December 1951
Present salary and grade	:	~~Rs.650/- (from 1.12.1982) in the grade 550-25-750-EB-30-900~~

1. Details of academic qualifications (degree onwards)

Examination	University/Institution	Class	Year
B.Sc.	Bombay University	I	1972
M.Sc.+	IIT, Bombay	II	1974
Ph.D.	IISc, Bangalore		1980

+was the holder of National Science Talent Scholarship from 1970-74

2. Details of service at the Institute

1.7 Ed 60 mem

Year		Designation
From	To	
~~1.1.1978~~ 1.12.1978	~~Present~~ 30.11.1983	Mathematical Programmer at C.T.S.
1.12.1983	17.7.1987	Scientific Officer at C.T.S.
18.7.1987	present	Lecturer CES

J1 → List of Publicat

J2 – Conf. Symposia attended.

REPORT OF WORK DONE DURING THE PERIOD UNDER REVIEW

3.1 Research and scientific investigations

The research carried out by Dr. N.V. Joshi primarily consists of the study of some biophysical, biological, ecological and meteorological phenomena, using various physical and mathematical concepts and techniques. Developing efficient procedures for computerization and statistical analysis of large sets of data is also one of his major interests.

After obtaining an M.Sc. degree in Physics, Dr. Joshi joined the Indian Institute of Science as a research student, in the Molecular Biophysics Unit, in August 1974. He was associated with the research program aimed at understanding the properties of molecules of biological importance, and carried out theoretical investigations on the flexibility of the six-membered rings of pyranose sugars. These studies were subsequently extended by him for elucidating the structure-activity relationships of some antibiotic drugs. The work involved extensive computation, and a number of computer programs were developed by Dr. Joshi for this purpose, thereby acquiring an expertise in FORTRAN programming on the IBM 360/44 system, then available at the Institute.

While still a research student at MBU, Dr. Joshi became interested in devising mathematical models to describe various biological phenomena, and informally interacted with the staff and students from various departments in the Institute. He subsequently joined the Centre for Theoretical Studies, as a Mathematical Programmer, in December 1978, and has been associated with the research activities of the Centre for the past five years.

Ever since he joined C.T.S. Dr. Joshi has proved to be a unique asset in the multiferous interdisciplinary research programs of the Centre. His keen interest in the mathematical modelling of phenomena in various areas such as ecology and meteorology, together with his expertise in working with the interactive DEC 1090 computer, have enabled him to make significant contributions to a number of research projects he was associated with. Some of the topics on which he has worked are: Population Dynamics, Estimation of Forest Productivity, Niche Overlap in Bird Communities, Cell-Cell communication and development, Quantitative ethology of Social Wasps, and a Cluster Analysis approach to the study of the distribution of rainfall patterns. In addition, he has also interacted enthusiastically with a number of scientists who worked at C.T.S. under the visitors' program.

The details of the scientific investigations carried out by Dr. Joshi have been furnished below:

1. Conformational Analysis

(a) Pyranose sugars:

The pyranose sugars form the building blocks for some of the most important and abundant polysaccharides, such as cellulose and starch. These polymers have been investigated by several theoretical techniques in the last two decades. Almost all the earlier model building studies on the polysaccharides have been conducted using a rigid geometry for the six-membered ring of the sugar. However, a detailed comparison of the crystal structures of various sugars suggested that the ring may be flexible to some extent.

The flexibility of the pyranose sugars was therefore investigated using classical potential energy functions. It was found that the sugar rings are indeed flexible. In fact, it was possible to obtain a large number of different geometries for sugar rings, which differ significantly from each other, but have nearly equal energies.

The results of this work are likely to be very useful for a better interpretation of X-ray diffraction data of polysaccharide fibers, and also for carrying out realistic Monte Carlo simulations on polymer chains.

Part of this work has been published, while two manuscrips are under preparation.

(ii) β-Lactam antibiotics

Pencillin, one of the most widely used antibiotics has lost its efficiency to some extent due to the emergence of strains of pencillin resistant bacteria. Several chemical modifications of pencillin have been successful to a lesser or greater extent against these strains. However, designing of more powerful drugs has to be an ongoing process.

For the design of new drugs, it is essential to understand the mechanism of action of the existing drugs. With this view in mind, conformational analysis of pencillin and pencillin sulfoxides was carried out. It is known that the drugs celphalosponins and clavulonic acid are active against pencillin resistant strains. The possible conformations which these drugs can obtain have also been investigated.

The results clearly isolate the stereochemical features responsible for the activity of pencillins. The relative activities of pencillin sulfoxides have also been accounted for. A comparison of pencillins and cephalosporins has indicated possible conformational features of the latter responsible for being active against the pencillin resistant strains. The methodology developed could be very useful for a very quick preliminary screening of a large number of compounds, such that only the really promising ones may be further used for experimentation.

This work is being continued by others at the M.B.U. and some of the programs developed by Dr. Joshi are still in use. This work was done at the Molecular Biophysics Unit under the supervision of Professor V.S.R. Rao.

2. Population Dynamics and Ecology

From the available data on fertility, mortality and predation, the status of the population of Sambars and Chitals at Bandipur was determined. Using the techniques of eigenanalysis or Leslie's matrix, as well as deterministic simulations, the sensitivity of these populations to changes in the ecosystem was investigated.

The extensive data on the movement of predators in Bandipur forest was analysed to determine their spatial distribution. The extent of overlap between the territories of different predators was also determined. Similar niche overlap analysis was extended to study the production of eggs by different species of birds during the breeding season.

Computer programs were also developed to analyse the available data on the productivity of different plant species in the forest. Productivities of various species and various groups of species was analysed for different months over the years, and at different sites.

All the analysis described above gave an excellent opportunity to have discussions with field biologists, so as to decide upon the effective mathematical techniques to analyse the available data. This also helped in developing an understanding of the difficulties in data collection in the field, which, in turn enables devising effective formats for data collection, to facilitate subsequent analysis on the computer.

This work was carried out with Professor Madhav Gadgil and his associates Dr. A.J.T. Johnsingh, Dr. S.N. Prasad and Mr. H.C. Sharatchandra.

3. Cell Biology and Chemical Kinetics

(i) Sensitivity of a cell to chemical stimulus: The cells of the slime mold Dicteostelium discoidium, during aggregation, communicate with each other using cAMP as a signal, which is detected by specific receptors on the cell surface. The extent to which these receptors are bound depends on their affinities as well as on the diffusion coefficients. The cAMP produced by the cell itself contributes to the background noise for the incoming signal.

Kinetic of the cAMP-receptor interactions were investigated for different profiles of the incoming signal, and the effects of diffusion on binding and on signal/ noise ratio were estimated.

(ii) Enhancement of chemosensitivity on a cell surface

The receptors on the cell surface are free to diffuse in the cell membrane. However, the diffusion coefficient for the free receptors may be different from that for the ligand-receptor complex. Under these circumstances, following an incoming pulse of the signal (ligand), under the joint effects of reaction and diffusion, the receptors are likely to be redistributed in such a way as to increase the sensitivity of the cell to the signal. This phenomenon was investigated by solving a one dimensional reaction diffusion equation, to determine the enhancement as function of the diffusion coefficients.

(iii) Signal processing on the cell surface

The signal processing pathway on the surface of a <u>Dictostelium</u> <u>discoidium</u> cell was modelled as a set of coupled reaction equations. Interaction of hormone (cAM)) with receptor, receptor with effector (enzyme) as well as that of hormone with the enzyme-receptor complex were taken into account. Equilibrium concentration, as well as the kinetics of the process were investigated, and the magnitude of the response (Binding of the hormone) was determined as a function of the dose (concentration of the hormone).

This work was done in collaboration with Dr. Vidyanand Nanjundiah, then at the C.T.S.

4. Drosophila : Dosage compensation and sex determination

The males of the fruit fly drosophila have only one X chromosome, while the females have two X chromosomes. However, the activity of the enzymes coded for by the enzymes on the X chromosome is nearly the same in the cells of females as well as males. This phenomenon is known as dosage compensation. A number of mutations of drosophila, with different chromosomal constitutions, are known, and it has been shown that the sex is determined not by the number of X chromosomes per se, but by the ratio of the number of X chromosomes to autosomes (X/A ratio). Moreover, the activity of the enzymes on the X chromosomes is also a function of this ratio, which in fact, is how dosage compensation is brought about. Both dosage compensation and sex determination are cell-autonomous properties.

A detailed molecular mechanism was proposed whereby a cell could determine the X/A ratio. This involved postulating a high affinity site and a low affinity site on the X chromosomes, to which a postulated repressor protein could bind. The repressor and RNA polymerase were postulated to compete for these sites, and also to modulate the affinities of each other.

This model was studied using deterministic simulations on the DEC 1090 computer. The binding of polymerase was determined under different chromosomal constitutions. Moreover, different mutants were simulated by altering the parameters corresponding to the affinities of the repressor to the sites on the X chromosomes, as well as by changing the concentrations of the constituents.

The results were quite gratifying. Not only could the available experimental data be easily explained, but a variety of different possible mutants could be predicted. The properties of the progeny obtained by crossing the available mutants could also be predicted very easily using the model.

This work was done in collaboration with Dr. Raghavendra Gadagkar, Dr. Vidyanand Nanjundiah and Professor H. Sharatchandra.

5. Social behaviour and population viscosity

The interactions between social behaviour and dispersal pattern of animal societies is one of the interesting contemporary problems. This was investigated by mathematical model building, using difference equations. The extent of dispersal was characterised by a dispersal parameter, while the social interaction was represented using the payoff matrix formalism of game theory. Using deterministic simulations, combined effect of social interactions and dispersal behaviour on the evolution of optimal strategies was investigated. More accurate results were subsequently obtained using analytical expressions.

The results have provided a theoretical basis for a lot of biological data, indicating a correlation between population viscosity and the extent of competition. The more co-operative animals tend to stay together, while the more competitive species tend to disperse widely.

The investigation of evolutionary stable strategies is an area of active interest in theoretical evolutionary biology. During the course of the present work, a formalism of 'fate maps' was developed, to depict outcomes of situations where the strategies chosen by the competitors are described by a continuous variable. This formalism may find a widespread use amongst evolutionary biologists.

This work was done in collaboration with Professor Madhav Gadgil and Professor Sulochana Gadgil.

6. Pattern formation and dispersal

Recent studies on chemical reaction-diffusion systems have indicated that such systems can give rise to a variety of spatial structures. It was therefore decided to extend these ideas to the study of the formation of animal population patterns. The dispersal of animal was modelled using a diffusion coefficient. The 'reaction', which corresponded to social interaction, was modelled using the payoff matrices of game theory. The stability of the system of these 'reaction-diffusion' equations was analysed. It was seen that for some of the realistic payoff matrices, under low dispersal, a uniform distribution is stable. However, when the diffusion coefficients are high and unequal, the uniform distribution becomes unstable and a spatial pattern is formed.

Studies are in progress to determine the various combinations of diffusion constants and payoff matrices which could give rise to interesting spatial patterns, such as bands, travelling waves, solitons, standing waves etc.

This investigation was carried out with Dr. Vidyanand Nanjundiah both at IISc, Bangalore and TIFR, Bombay.

7. Quantitative study of the behaviour and ecology of social wasps

Social insects have been one of the most intriguing systems for behavioural biologists, and have been a subject of several detailed studies. Especially with the recent advances in the understanding of several aspects of natural selection, the study of social behaviour of social insects has received a new impetus.

Dr. Raghavendra Gadagkar of the CTS has been carrying out detailed observations on the ecology of the colonies of the social wasps; and also maintaining records of the behavioural patterns of several individually marked wasps. He has been especially interested in studying the behavioural caste-differentiation in wasps, where morphological caste determination is nearly absent. The work described here, carried out in collaboration with him, consists of a detailed statistical analysis of this data, carried out on the DEC 1090 computer.

(i) Behavioural caste differentiation

Using the data on time spent by individually marked wasps in performing each of a set of behaviours, time activity budgets were prepared for each of the wasps on a colony. A multivariate analysis of these time activity budgets, using principal component analysis, indicated the existence of three different castes amongst the wasps. By studying the behavioural profiles of the members of these castes, they were named as sitters, fighters and foragers. This is perhaps one of the first instances where rigorous, quantitative and objective methods have been employed to determine the existence of behavioural castes in social wasps.

(ii) Ecology and population dynamics of wasp colonies

Data on establishment and growth of colonies of paper wasps was analysed. From the week to week data on populations on colonies, transition matrices were obtained to describe the growth of a typical wasp colony. Using deterministic simulations, the effect of the number of foundresses on the success of a colony was investigated. Probabilities for transition from one developmental stage to the other were used to estimate the developmental times of the egg, larva and pupa. The extent of parasitization was also determined.

Professor Madhav Gadgil and Dr. Anil Mahabal of ZSI were also associated with this part of the work.

(iii) Colony split in Ropalidia cyathiformis

One of the most fascinating phenomenon observed in the social wasps is that of a colony split. During this episode, a few adult wasps desert the parent colony and found a new one. There are costs associated with this process, since chances that a new colony will be successfully established are small. However, a much better hierarchial status (dominance rank) on the new colony constitutes an advantage. The process by which a group of wasps decide on a split, especially as a group, is not understood, and constitutes a challenging problem.

A detailed observation of individually marked adult wasps on a colony before, during and after the split, carried out by Dr. Raghavendra Gadagkar, constitutes the basis of one of the first quantitative study of such a process.

Time activity budgets, reproductive success and dominance status of adult wasps were computed from the above data. The reproductive success was low in the conflict phase, but improved markedly in both the colonies after the split. The dominance status of the wasps which left the parent colony was seen to have improved. Using statistical techniques, it was established that the wasps in the group which left the colony used to be together more often, and tended to avoid those which did not leave the colony. More detailed studies on the communication between wasps are likely to throw light on the decision making process.

8. Climatic classification

This work was done in collaboration with Professor Sulochana Gadgil.

Climatic classification essentially involves dividing a region into subregions, such that the stations within a subregion have similar climates, while those belonging to diffefent subregions have different climates. Such a division is useful for many purposes, e.g. for making meteorological predictions, planning of agricultural strategies, establishment of centers of agricultural research etc.

Using the multivariate technique of principal component analysis, a rational and objective method of obtaining climatic clusters was developed. This involved representation of the meteorological stations as points in the n dimensional space of the relevant variables, (e.g. monthly rainfall, monthly potential evapotranspiration etc.). This was reduced to a two dimensional representation, without significant loss of information, using the principal component analysis techniqu . Clusters could then be visually identified from such a two dimensional map. These clusters were then tested for splitting and merging, using criteria developed at the C.T.S. to obtain an objective, self consistent set of clusters.

This method has proved to be of much utility, as it can distinguish distinct subregions inside the broad regions previously thought to be homogeneous. Moreover, the clusters obtained by this method are much more realistic, since they are based on the detailed variation of the meteorological variables throughout the year.

This methodology was extended to include, in addition to the rainfall distribution, distribution of the moisture index, and of temperature, throughout the year. A detailed climatic classification of the Indian region was obtained in this manner.

The success of this method was much appreciated, and active interest was shown in this work by other agencies such as ICRISAT, Hyderabad and Karnataka State Bureau of Economics and Statistics.

The set of programs developed for this purpose forms a very convenient package, and has found uses in such diverse fields as wind pqttern analysis, behavioural studies, and determination of distinctive patterns of flavours of ginger, the last one being carried out at CFTRI, Mysore.

9. Analysis of feeding patterns of birds

This work was done in collaboration with Mrs. Lalitha Vijqyan of Bombay Natural History Society, who,as a part of her doctoral work, had carried out the field studies on the ecology of different species of drongoes.

Feeding position preferences for various species of drongoes were determined ffom the proportions of sightings in different layers of the canopy. Similar analysis was carried out for food preferences. The seasonal variations in these patterns were also determined, as the data was available for an entire year.

To determine the extent of competition between different species, nich breadths were computed for each specie, and niche overlaps for each pair of species. A reduction in the niche breadth of a specie in the presence of another specie, for example, indicates that the latter interferes directly or indirectly with the former. However, such a conclusion can be drawn only if the reduction in niche breadth is appreciable, as well as statistically significant. Since no analytical techniques were readily available for testing of statistical significance, computer programs were developed to carry out these tests using Monte Carlo methods. It is hoped that more use would be made of these methods so as to make quantitative analysis of ecological data more rigorous.

The data collected was also used to obtain the flock sizes of each species of the birds studied, and for obtaining the size distribution of flock sizes of mixed feeding parties. frequencies of co-occurrence for each pair of species in mixed feeding parties were computed. Statistical significance of such pairwise association coefficients was examined. These results would be very useful in understanding the structure of bird communities in a given ecosystem.

3.2 Teaching

Dr. Joshi had been involved in the teaching of the course 'Mathematical Modelling for Biologists' along with Dr. Vidyanand Nanjundiah (Jan-April 1980). In addition to the lectures, this involved conducting tutorials, developing computer programs to simulate various biological systems, demonstrations of these programs on the interactive terminal, as well as evaluation of the students.

He was one of the instructors for the course on 'Computer Programming for Biophysicists and Biologists' in Aug-Dec 1981, along with Professor C. Ramakrishnan and Mr. M. Jagannath Rao of M.B.U. and Professor Madhav Gadgil of C.T.S. The course was fairly intensive, and individual attention was provided to almost each of the thirty students.

He was associated with a course on 'Conformation of Polysaccharides' given by Professor V.S.R. Rao of M.B.U. (Aug-Dec. 1982), in teaching FORTRAN Programming with special emphasis on applications to the conformations of mono, oligo and poly-saccharides. He is associated with the same course for the current session as well. (Aug-Dec. 1983)

In addition to this, he had been associated with an informal supervision of some of the students registered for Diploma in Molecular Biophysics, and the extent of advise given can be judged by the explicit acknowledgements in these dessertations.

3.3 Other contributions and academic/technical activities

3.3.1 Programming for C.T.S. faculty and visitors

The computational requirements for the physics faculty at the Centre for Theoretical Studies have been marginal so far. A few numerical integrations were carried out for Professor J. Pasupathy. Some programs were developed incorporating numerical integration, least square analysis and parameter estimation for further computations connected with the theoretical work carried out by Professor J. Pasupathy.

One of the significant features of the Centre for Theoretical Studies is the Visitors' Program, whereby a number of scientists in India visit the Centre for periods ranging from a few days to a few months, for carrying out scientific work. Some of the visitors - physicists, biologists, ecologists etc. required the computer facilities. Support was extended to them in the form of advise on the mathematical techniques, as well as by carrying out detailed computations on the DEC 1090 system. Following is a very brief account of the work undertaken for the various visitors:

1) Numerical integrations were carried out for Dr. S.S. Raghavan, a theoretical physicist from Bhubaneshwar, Orissa.

2) Statistical analysis was carried out on the data on the heights, girths and productivity of the trees in an evergreen forest, for Dr. S.N. Rai, Dy. Conservator of Forests, Dharwar.

3) Mathematical analysis of the home range and territory size, as well as statistical analysis of the activity patterns of the black buck, was carried out for Dr. N.L.N.S. Prasad, Osmania University, Hyderabad.

4) Numerical simulations of regeneration patterns in hydra, with and without grafting, under various experimental conditions were carried out for Dr. Somdatta Sinha of the Jawaharlal Nehru University, New Delhi.

5) Statistical analysis of communication patterns, including the determination of efficiency of information transfer, for elephants was carried out for

Mr. P.V.K. Nair of Kerala Forest Research Institute, Peechi.

3.3.2 Activities in the Department

The activities in the department essentially consisted of participating in organising lectures and seminars. Thus, a series of lectures was arranged on the structural aspects of unwinding of DNA. A series of seminars was also arranged on Topics in Theoretical Ecology. An active interest was taken in participating in the series of seminars on 'Vision' organised by Dr. Vidyanand Nanjundiah.

3.3.3 Activities in the Institute

Dr. Joshi was one of the group of students, who from time to time, have given a list of detailed suggestions for the improvement in the day to day working of the Computer Center. He was also on the Computer Users' Committee, and participated in the meetings. During December 1981, at the invitation of the Chairman of Computer Advisory Committee, he participated in devising and implementing a scheme of the allotment of terminal slots commensurate with the previous usage.

He has also worked as invigilator during the entrance examination held at the Institute during 1983.

3.3.4 Scientific consultancy

The agroclimatology group at ICRISAT, Hyderabad, expressed a keen interest in the work on climatic classification carried out at the C.T.S. by Professor Sulochana Gadgil. In fact, they requested Dr. Joshi to visit ICRISAT as a consultant for carrying out a similar analysis on Indian as well as African stations. Accordingly, he visited ICRISAT in February 1982 as well as in June 1982, and adopted the cluster analysis package to the Vax-VMS system available at that Institute. The results of this analysis are likely to be extremely useful in choosing the appropriate regions in Africa, where the agricultural practises developed at the ICRISAT could be most successfully transferred. This analysis would also be useful for choosing the site of new research stations. While at ICRISAT, he also developed programs to analyse the rainfall distribution data available there, and to fit various statistical distributions.

The Karnataka State Bureau of Economics and Statistics has requested Professor Sulochana Gadgil to explore the possibility of carrying out a climatic classification for Karnataka State. Dr. Joshi was also a collaborator in this project, which resulted in a report submitted to the Government of Karnataka.

3.3.5 Miscellaneous academic activities

Dr. Joshi has actively interacted with students from various departments in the Institute, such as M.B.U., M.C.B.L., Organic Chemistry, Physics etc. His activities included informally reviewing manuscripts, suggesting mathematical or computational algorithms, developing programs as well as advising fellow research workers especially about the methods of conformational energy calculations. His contributions have been much appreciated by his fellow students, and he has been explicitly acknowledged in several publications as well as thesis.

A talk on 'Principles of conformational analysis' was given to the crystallography group at the Central College, Bangalore University, in August 1979.

He has also acted as a referee for the Journal of Theoretical Biology and for Current Science.

3.4 Activities for Seminars, Workshops, Symposia etc.

Dr. Joshi was involved in the organization of a workshop on 'Evolution of Social Behaviour' held at Mahabaleshwar in October 1979. In particular, he participated in the preparation of a'Primer of Sociobiology', and contributed chapters on topics such as group selection, parent offspring conflict, sociality and foraging efficiency etc. Each chapter consisted of a brief discussion of the topic, followed by a number of worked examples. The primer was much appreciated by the participants.

He was also a delegate in the 'Indo US Workshop on Maintenance of Biological Diversity', held at Bangalore in March 1982, and participated in the discussions on formulating the guidelines on the choice of biosphere reserves.

He had also been invited to participate in the seminar on Mathematical and Engineering Concepts in Medical and Biological Research, held at Bangalore in April 1982.

Dr. Joshi gave two invited lectures at the pre-planning meeting of the ICRISAT/WMO symposium on 'Agrometeorology of Sorghum and Millets in the Semi-arid Tropics', held at ICRISAT, Patancheru, Andhra Pradesh in November 1982. He discussed various clustering mothodologies as applied to agricultural meteorology.

He was also associated with the organization of the workshop on "The Frontiers of Evolutionary Biology" conducted by the Centre for Theoretical Studies at Rishi Valley, Andhra Pradesh, in June 1983. He gave a lecture on 'Group Selection' in the workshop.

LIST OF PUBLICATIONS

1. Theoretical studies on β-lactam antibiotics. Conformational Flexibility of the Five-membered ring in Clavulanic acid and Pencillin and the Binding Specificity of β Lactamases.

   N.V. Joshi, R. Virudachalam and V.S.R. Rao

   Current Science, 47, 933-936 (1978)

2. Flexibility of the pyranose ring in α-and β-D Glucopyranoses

   N.V. Joshi and V.S.R. Rao

   Biopolymers, 18 2993-3004 (1979)

3. Use of Principal Component Analysis in Rational Classification of Climates

   Sulochana Gadgil and N.V. Joshi

   in Climatic Classification : A Consultant's Meeting, page 17-26 ICRISAT, Hyderabad, India, April (1980)

4. Measurement of the Ratio of the number of X chromosomes to Sets of Autosomes in Drosophila Melanogaster

   Raghavendra Gadagkar, V. Nanjundiah, N.V. Joshi and H. Sharat Chandra

   Current Science, 50, 805-807 (1981)

5. Theoretical Studies on β Lactam Antibiotics : Conformational Analysis of Pencillin Sulfoxides and Cephalosporins

N.V. Joshi and V.S.R. Rao

Journal of Biosciences, 4 209-218 (1982)

6. Behaviour of the Indian Social Wasp Ropalidia Cyathiformis (Fab) on a nest of separate combs (Hymenoptera:Vespidae)

R. Gadagkar and N.V. Joshi

J. Zool.(London) 198, 27-37 (1982)

7. Cluster Analysis of Rainfall Stations of Karnataka

Sulochana Gadgil, Savita Bagavant

N.V. Joshi and L.M. Hegde (1982)

Report published by the Bureau of Economics and Statistics, Government of Karnataka, Bangalore, India

8. Dosage Compensation and Sex Determination in Drosophila : Mechanism of measurement of the X/A ratio

Raghavendra Gadagkar, Vidyanand Nanjundiah, N.V. Joshi and H. Sharat Chandra

Journal of Biosciences 4, 377-390 (1982)

9. A Comparative Study of Social Structure in Colonies of Ropalidia
   Raghavendra Gadagkar and N.V. Joshi
   In the Biology of the Social Insects, (eds.) M.D. Breed, C.D. Michner and H.E. Evans, Proc. IX Congress of the International Union for the Study of Social Insects, Boulder, Colorado, USA (1982) pp 187-191

10. When a Wasp Colony Splits
   Raghavendra Gadagkar and N.V. Joshi
   In the Biology of the Social Insects (eds.) M.D. Breed, C.D. Michner and H.E. Evans, Proc. IX Congress of the International Union for the Study of Social Insects, Boulder, Colorado, USA (1982) pp 217

11. Observations on the Natural History and Population Ecology of the Social Wasp Ropalidia Marginata
   Raghavendra Gadagkar, Madhav Gadgil, N.V. Joshi and A.S. Mahabal
   Proceedings of the Indian Academy of Sciences, (Animal Sciences) 91, 539-552 (1982)

12. Quantitative Ethology of Social Wasps : Time Activity Budgets and Caste Differentiation in Ropalidia Marginata (Lep.) (Hymenoptera:Vespidae)
    Anim. Behav. 31, 26-31 (1983)

13. Climatic Clusters of the Indian Region
    Sulochana Gadgil and N.V. Joshi
    Journal of Climatology, 3, 47-63 (1983)
    [A technical report with the same title, based on the above paper, has been prepared]

14. Social Organization in the Indian Wasp Ropalidia Cyathiformis (Fab.)
    Raghavendra Gadagkar and N.V. Joshi
    Z. Tierpsychology, 1983 (in press)

15. On the Moulding of Population Viscosity by Natural Selection
    Madhav Gadgil, N.V. Joshi and Sulochana Gadgil
    Journal of Theoretical Biology 1983 (in press)

BIODATA

NIRANJAN V. JOSHI

Date of birth : 14 December 1951

Designation : Lecturer

Address : Centre for Ecological Sciences
Indian Institute of Science
Bangalore 560012, India

Academic Qualifications

1. B.Sc. Bombay University, I Class, 1972
2. M.Sc. IIT, Bombay, II Class, 1974
3. Ph. D, Indian Institute of Science, Bangalore, 1980

Positions held :

1.	Mathematical Programmer	Centre for Theoretical Studies, IISc.	1978-1983
2.	Scientific Officer	"	1983-1987
3.	Lecturer	Centre for Ecological Sciences, IISc.	1987-

Awards:

National Science Talent Scholarship 1970-74

Seminars , Symposia , Workshops etc attended

(where presentations were made)

1. Workshop on ` Frontiers of Evolutionary Biology '
   Rishi Valley , A.P. , India. June 1983
2. Mahabaleswar Seminar on Modern Biology : Theories in Biology
   Rishi Valley , A.P. , India. September 1984
3. International Conference on Mathematical Modelling
   Berkeley , California , U.S.A. July 1985

4. Workshop on ` Statistical Ecology '
   Univ. of Poona , Pune , India. December 1985

5. Symposium on ` Sociogenetics in Insects '
   X Congress of IUSSI , Munich , F.R.G. August 1986

6. National Workshop on ` Conservation Biology '
   C.E.S. , I.I.Sc. , Bangalore , India. December 1986

7. Workshop on ' Neural Networks '
   C.T.S. , I.I.Sc. , Bangalore , India. January 1987

8. Workshop on ` Order - Chaos - Catastrophe '
   Max Mueller Bhavan , Bombay , India. October 1987

9. First Asian School on ` Conservation Biology '
   C.E.S. , I.I.Sc. , Bangalore , India. December 1987

List of publications

<u>Theoretical</u> <u>Biology</u>

1. Evolution of Co-operation by Reciprocation within Structured Demes
   -N.V.Joshi
   J.Genetics <u>66</u> , 69-84 (1987)

2. Evoluation of Sex Ratios in Social Hymenoptera : Consequences of Finite Brood Size
   -N.V.Joshi
   J.Genetics <u>65</u> ,55-64 (1986)

3. Testing Sex Ratio Theory within Social Insects
   -N.V.Joshi
   In 'Chemistry and Biology of Social Insects ' , J. Eder and H. Rembold (Eds) , Verlag J. Peperny , Munchen , pp 343-344 (1987)

4. Kin Recognition, polygamy and the Sex Ratio
   -N.V.Joshi
   In 'Chemistry and Biology of Social Insects ' , J. Eder and H. Rembold (Eds) , Verlag J. Peperny , Munchen , pp 481 (1987)

5. Evolution of Sex Ratios in Social Hymenoptera : Kin Selection, Local Mate Competiton, Polyandry and the Sex Ratio
   -N.V.Joshi and R.Gadagkar
   J.Genetics <u>64</u> , 41-58 (1985)

6. On the communication of Well-being
   -M.Gadgil, M.Hedge, N.V.Joshi and S.Gadgil
   Proc.Ind.Acad.Sci.(animal Sciences) <u>94</u>, 575-586 (1985)

7. A Four-Variable Model for the pattern Forming Mechanism in Hydra
S.Sinha, N.V.Joshi, J.Subba Rao and S.Mookerji
Biosystems 17, 15-22 (1984)

8. On the Moulding of Population Viscosity by Natural Selection
M.Gadgil, N.V.Joshi and S.Gadgil
J.Theor.Biol. 104, 21-42 (1983)

9. Dosage Compensation and Sex Determination in Drosophila : Mechanism of measurement of the X/A Ratio
R.Gadagkar, V.Nanjundiah, N.V.Joshi and H.Sharat Chandra
J.Biosciences 4, 377-390 (1982)

10. Measurement of the Ratio of X-Chrosomes to sets of Autosomes in Drosophila melanogaster
-R.Gadagkar, V.Nanjundiah, N.V.Joshi and H.Sharat Chandra
Curr.Sci. 50, 805-807 (1981)

Statical Analysis of Behavioural Data

11. Colony Fission in a Social Wasp
-R.Gadagkar and N.V.Joshi
Curr.Sci. 54, 57-62 (1985)

12. Social Organization in the Indian Wasp Ropalidia cyathiformis (Fab.)
-R.Gadagkar and N.V.Joshi
Z.Tierpsychol 64, 15-32 (1984)

13. Quantitative Ethology of Social Wasps : Time-Activity Budgets and Caste Differentiation in Ropalidia marginata (Lep.) (Hymenoptera : Vaspidae)
-R.Gadagkar and N.V.Joshi
Anim.Behav. 31, 26-31 (1983)

14. Observations on the Natural History and population Ecology of the Social Wasp Ropalidia marginata
-R.Gadagkar, M.Gadgil, N.V.Joshi and A.S.Mahabal
Proc.Ind.Acad.Sci. (Animal Sciences)91, 539-552 (1982)

15. A Comparative Study of Social Structure in Colonies of Ropalidia
-R.Gadagkar and N.V.Joshi
Proc. IX Congress of IUSSI, 187-191 (1982)

16. When a Wasp Colony Splits
-R.Gadagkar and N.V.Joshi
Proc.IX Congress of IUSSI, 213 (1982)

17. Behaviour of the Indian Social Wasp Ropalidia cyathiformis (Fab.) on a Nest of Seperate Combs
-R.Gadagkar and N.V.Joshi
J.Zool (London) 198, 27-37 (1982)

Climatology

18. Ocean-Atmosphere Coupling over Monsoon Regions
    -S.Gadgil, P.V.Joseph and N.V.Joshi
    Nature 312,141-143 (1984)

19. Climatic Clusters of the Indian Region
    -S.Gadgil and N.V.Joshi
    J.Climatology 3, 47-63 (1983)
20. Cluster Analysis of Rainfall Stations of Karnataka
    -S.Gadgil, S.Bagavant, N.V.Joshi and L.M.Hedge
    Report Published by the Bureau of Economics and Statistics, Govt. of Karnataka, Bangalore, India (1982)

21. Use of Principal Component Analysis in Rational Classification of Climates
    -S.Gadgil and N.V.Joshi
    Climate Classification : A Consultants' Meeting, ICRISAT, Hyderabad, India (1980)

Molecular Biophysics

22. Theoretical Studies on ^[a^\-Lactam Antibiotics : Conformational Analysis of Penicillin Sulfoxides and Cephalosporins
    -N.V.Joshi and V.S.R.Rao
    J.Biosci.4, 209-218 (1982)

23. Flexibility of the Pyranoise Ring in ^[`^\-and ^[a^\-D-Glucopyranoses
    -N.V.Joshi and V.S.R.Rao
    Biopolymers 18, 2993-3004 (1979)

24. Theoretical studies on ^[a^\ -Lactam antibiotics : conformational Flexibility of the five-Membered Ring in clavulanic acid and the Binding specificity of -Lactamases
    -N.V.Joshi, R.Virudachalam and V.S.R.Rao
    Curr.Sci. 47,933-936 (1978)

General

25. Computer simulations for the Workshop on Conservation Biology
    -N.V.Joshi
    Technical Report No.44,Centre for Ecological Sciences, Bangalore, India (1987)

26. Workshop on Frontiers of Evolutionary biology
    -N.V.Joshi
    J.Sci.Ind.Res. 42,659-662 (1983)

P R O F O R M A

Name of the member of staff .. N.V. JOSHI

Designation .. ASSISTANT PROFESSOR

Department .. CENTER FOR ECOLOGICAL SCIENCES

Age and Date of Birth .. 45 YEARS ; 14 DEC 1951

Present Salary and Grade .. Rs 4325 with effect from JAN 1991

in the grade Rs 3700-125-4950-150-5700

1. DETAILS OF ACADEMIC QUALIFICATIONS:
(Degree onwards)

Examination	University/ Institution	Class obtained	Year of obtaining the degree
B. Sc.	BOMBAY UNIVERSITY	I	1972
M. Sc.	I.I.T., BOMBAY	II	1974
Ph.D.	I.I.Sc., BANGALORE	—	1980

1.1 Membership of Professional Bodies:/ Editorial board membership

~~International Union~~ 1. Fellow, Indian Academy of Sciences

2. Member, Editorial Board, Current Science

~~3. Member, International Union for the Study of Social Insects~~

2. DETAILS OF SERVICE AT THE INSTITUTE:

Year		Designation
From	To	
29 Dec 1990	Present	Assistant Professor at the Center for Ecological Sciences
18 July 1987	28 Dec 1990	Lecturer "
1 Dec 1983	17 July 1987	Scientific Officer at the Center for Theoretical Studies
1 Dec 1978	30 Nov 1983	Mathematical Programmer "

3. REPORT ON RESEARCH/TEACHING/INDUSTRY INTERACTION DURING THE PERIOD UNDER REVIEW:

This section deals with three components namely, Research, Teaching and interaction with industry. The sub-headings given are for guidance and the staff member can highlight only those activities with which he is concerned with. For example, there is no need to give the sub-headings and write NIL or Not Applicable, if the sub-heading is not relevant to the staff member's contributions.

3.1 Research and Scientific Investigations:

3.1.1 Guidance of students for research conferments: omit
(Please indicate the number)

At the time of appointment/last review		During the period under review	
PhD	Nil	—	Awarded
		— ~~1~~	Thesis submitted
		—	Under Progress
MSc(Engg.)			Awarded
			Thesis submitted
			Under Progress

3.1.2 Sponsored Projects (Research Schemes)

Title	Funding Agency	Value	Duration	Co-investigators
Multivariate Statistical Analysis of the data generated under the People of India project	Anthropological Survey of India, ~~Govt~~ Govt. of India	Rs. 12 lakhs	Three years 1993 – 1996	Shri Suresh Patil Anthropological Survey of India Southern Regional Office Mysore.

3.1.3 Publications: (Please attach list)

(Please indicate the percentage of your contribution in each of the publications in the list attached by you)

At the time of appointment/last review	During the period under review
37 (Total)	13 Published in Journals 7 Presented at Conferences/ Seminars/Symposia 1 Submitted for publication – Reports/Monographs etc. 3 Others (Please specify) Book review

3.1.4 Brief resume of Research and Development Work carried out during the period under review (to be limited to 1000 words only)

3.2 <u>Teaching</u>:

3.2.1 Courses taught:

Title of Course	Credits	No. of times offered	Taught alone / jointly	Student feedback if available	Any othe remarks
100 level		93			
200 level		95			
300 level		96			

3.2.2 Guidance of students:

	At the time of appointment/ last review	During the period under review
ME/MTech	______	______
Projects	______	______
Please indicate numbers.		

(It may be indicated how many projects are sponsored, and the technology transfer/products developed through these projects)

3.2.3 List books and other education material developed.

3.2.4 List projects in education/short term courses organised:

Sl.	Course	Sponsoring agency	Duration	Target group	Cost of course

3.3 Industrial Research/Development/:

3.3.1 Consultancy Projects:

Title	Funding Agency	Value	Duration	Co-consultants	Deliverables

3.3.2 Projects with industries (other than through Consultancy projects)

3.3.3 Patents and Design Registrations:

3.3.4 A brief summary of interaction with industry

4. Services provided (e.g. set up of laboratories, software, network, testing, maintenance and operation of facilities, etc.)

5. Work done for the Faculty/Senate:

6. Visits abroad during the period under review:

7. Awards/Recognitions, if any:

8. Future Plans (Max. 500 words only)

9. Any other relevant information:

BIODATA

NIRANJAN V. JOSHI

Date of birth : 14 December 1951

Designation : Assistant Professor

Address : Centre for Ecological Sciences
Indian Institute of Science
Bangalore 560012, India

Academic Qualifications

1. B.Sc. Bombay University, I Class, 1972

2. M.Sc. IIT, Bombay, II Class, 1974

3. Ph. D, Indian Institute of Science, Bangalore, 1980

Positions held :

1.	Mathematical Programmer	Centre for Theoretical Studies, IISc.	1978-1983
2.	Scientific Officer	"	1983-1987
3.	Lecturer	Centre for Ecological Sciences, IISc.	1987-1990
4.	Assistant Professor	"	1991-

RESEARCH EXPERIENCE

Doctoral research carried out at the Molecular Biophysics Unit, Indian Institute of Science, Bangalore consisted of using theoretical and computational procedures for determining the shapes and flexibility of some biomolecules - pyranose sugars and antibiotics such as penicillin sulfoxides and cephalosporin. This involved not only devising algorithms and developing computer programs, but also interpreting the structure - activity relationships elucidating the biological properties of the molecules from their structure.

Subsequent appointment at the Centre for Theoretical Studies, Indian Institute of Science, Bangalore involved providing mathematical, statistical and computational support to the faculty of the C.T.S. as well as to the large number of scientists visiting the Centre for various durations. This proved to be a unique opportunity for interacting with researchers from a variety of disciplines - meteorology, cell biology, genetics, animal behaviour, ecology and sociobiology. Apart from being exposed to many exciting areas of (mainly) biology, this led to a familiarity with many of the mathematical and statistical methods used in these areas, and with the processing, analysis and interpretation of large, complex and varied data sets. Even more important was the experience gained by interacting with biologists obtaining an adequate understanding of their research topic, so as to choose the appropriate analytical technique, explaining the quantitative results obtained in a form intelligible to them, and continuing further analysis based on their response. This also involved the use and development of various methods of graphical and visual presentation of data and results for obtaining better insights.

Since joining the Centre for Ecological Sciences, Indian Institute of Science, Bangalore in 1987, the research has been mainly in the area of evolutionary biology and ecology. Studies in evolutionary biology involved formulation and analysis of population genetic models to explore conditions favourable for the evolution of different attributes in different biological systems - optimal sex ratios in social insects, optimal resource allocation between seeds in plants, sexuality itself in single celled organisms, cooperative behaviour in structured populations, to name a few. Ecological research ranges from modelling of optimal harvesting strategies, to analysing patterns of distribution and abundance of bird and plant species, and generating prescriptions for conservation measures based on these studies. There has been more than passing interaction with colleagues at the Centre working on revegetation, carbon sequestration potential of forests, renewable energy resource utilization, and energy efficiency and end-use studies in small scale industry sector, fuel efficient wood-stoves etc. From the last quarter of 1991, main research effort is directed at the analysis of the cultural diversity of the Indian population, based on an extensive ethnographic survey of over 2500 human communities carried out by the Anthropological Survey of India between 1985-1991, under the monumental 'People of India' project.

Other Academic Activities

1. *Membership of professional societies :*

   Fellow, Indian Academy of Sciences, Bangalore. (1992 -)

2. *Seminars given outside the Institute at :*

   B.A.R.C., Bombay

   Department of Statistics , University of Poona

   CMMACS , N.A.L. , Bangalore

   University of Agricultural Sciences , Bangalore

3. *Reviewing manuscripts for :*

   Journal of Theoretical Biology

   Current Science

   Journal of Genetics

   Journal of The Indian Academy of Sciences (Animal Sciences)

   Journal of the Indian Institute of Science

   Indian Journal of Marine Sciences

   Journal of Biosciences

4. *Examiner for :*

   GATE examination 1988 (section on Environmental Engg.)

   Dissertations for M.Sc.(Wildlife Biology) 1989 conducted by Wildlife Institute of India, Dehra Dun (Saurashtra University)

   M.S. in Ecology (paper setting and evaluation) Salim Ali School of Ecology, Pondicherry University (1991-92)

   Ph.D. Thesis , School of Environmental Sciences Jawaharlal Nehru University , New Delhi (1990).

   Ph.D. Thesis, Dept. of Marine Sciences Goa University, (1992)

5. *Courses offered in the Institute :*

Mathematics and Programming for Biologists (1985, 1989)

Mathematical Modelling in Ecology (1986,1987,1988)

Computer Simulations in Ecology (1988,1989,1990)

6. *Participation in sponsored Research :*

(i) 'Cultural Evolution of Ecological Prudence'
Department of Science & Technology , Govt. of India
Jan 1987 - March 1990

(ii) 'Long term collaboration with the Center for Ecological Sciences, I.I.Sc. for Multivariate analysis of the data generated under the People of India Project'
Anthropological Survey of India, Govt. of India
April 1993- (anticipated up to April 1996)

PUBLICATIONS

I. In journals/books etc.

<u>Theoretical Biology</u>

1.Sibling rivalry betwwen seeds within a fruit :
Some population genetic models.
- N.V.Joshi
Journal of Genetics, <u>71</u>, 105-119 (1992)

2.Evolution of polyembryony :
Consequences to the fitness of mother and offspring
- K.N.Ganeshaiah, R.Uma Shaanker and N.V.Joshi
Journal of Genetics, <u>70</u>, 103-127 (1991)

3.On the role of refugia in harvesting biological populations
- N.V.Joshi and Madhav Gadgil
Theoretical Population Biology, <u>40</u>, 211-229 (1991)

4.Transposable element-mediated evolution of sex :
A population genetic model
- N.V.Joshi
Journal of Genetics , <u>69</u>, 127-139 (1990)

5.Evolution of Polyandry by reduction in progeny number
variance in structured populations.
- N.V.Joshi
Journal of Genetics , <u>67</u>,161-171 (1988)

6.Evolution of Co-operation by Reciprocation within Structured Demes
-N.V.Joshi
J.Genetics <u>66</u> , 69-84 (1987)

7.Testing Sex Ratio Theory within Social Insects
-N.V.Joshi
In 'Chemistry and Biology of Social Insects ' , J. Eder and H.
Rembold (Eds) , Verlag J. Peperny , Munchen , pp 343-344 (1987)

8.Kin Recognition, polygamy and the Sex Ratio
-N.V.Joshi
In 'Chemistry and Biology of Social Insects ' , J. Eder and H.
Rembold (Eds) , Verlag J. Peperny , Munchen , pp 481 (1987)

9.Evoluation of Sex Ratios in Social Hymenoptera : Consequences
of Finite Brood Size
-N.V.Joshi
J.Genetics <u>65</u> ,55-64 (1986)

10.Evolution of Sex Ratios in Social Hymenoptera : Kin Selection,
Local Mate Competiton, Polyandry and the Sex Ratio
-N.V.Joshi and R.Gadagkar
J.Genetics <u>64</u> , 41-58 (1985)

11.On the communication of Well-being
-M.Gadgil, M.Hedge, N.V.Joshi and S.Gadgil
Proc.Ind.Acad.Sci.(animal Sciences) <u>94</u>, 575-586 (1985)

12.A Four-Variable Model for the pattern Forming Mechanism in Hydra
-S.Sinha, N.V.Joshi, J.Subba Rao and S.Mookerji
Biosystems <u>17</u>, 15-22 (1984)

13.On the Moulding of Population Viscosity by Natural Selection
-M.Gadgil, N.V.Joshi and S.Gadgil
J.Theor.Biol. 104, 21-42 (1983)

14.Dosage Compensation and Sex Determination in Drosophila : Mechanism of measurement of the X/A Ratio
-R.Gadagkar, V.Nanjundiah, N.V.Joshi and H.Sharat Chandra
J.Biosciences 4, 377-390 (1982)

15.Measurement of the Ratio of X-Chrosomes to sets of Autosomes in *Drosophila melanogaster*
-R.Gadagkar, V.Nanjundiah, N.V.Joshi and H.Sharat Chandra
Curr.Sci. 50, 805-807 (1981)

Statistical Analysis of Behavioural and Ecological Data

16.Exploring cultural diversity of the people of India
-N.V.Joshi, Madhav Gadgil and Suresh Patil
Current Science, 64, 10-17 (1993)

17.Long-term monitoring of vegetation in a tropical deciduous forest in Mudmalai, southern India
-R.Sukumar, H.S.Dattaraja, H.S.Suresh, J.Radhakrishnan, R.Vasudeva, S.Nirmala and N.V.Joshi
Current Science, 62, 608-616 (1992)

18.On the relationship between bird and woody plant species diversity in the Uttara Kannada district of south India.
-R.J.Ranjit Daniels, N.V.Joshi and Madhav Gadgil
Proc.Natl.Acad.Sci.USA, 89, 5311-5315 (1992)

20.Assigning conservation value: a case study from India
-R.J.Ranjit Daniels, Malati Hegde, N.V.Joshi and Madhav Gadgil
Conservation Biology 5, 464-475 (1991)

21. Changes in the bird fauna of Uttara Kannada in relation to changes in land use over the past century
- Daniels , R.J.R. , Joshi ,N.V. and Gadgil , M.
Biological Conservation 52, 37-48 (1990)

22. Growth in the Asian Elephant
-R. Sukumar, N.V. Joshi and V. Krishnamurthy
Proceedings of the Indian Ascademy of Sciences (Animal Sciences) 97,561-571 (1988)

23. Colony Fission in a Social Wasp
-R.Gadagkar and N.V.Joshi
Curr.Sci. 54, 57-62 (1985)

24. Social Organization in the Indian Wasp *Ropalidia cyathiformis*
-R.Gadagkar and N.V.Joshi
Z.Tierpsychol 64, 15-32 (1984)

25. Quantitative Ethology of Social Wasps : Time-Activity Budgets and Caste Differentiation in *Ropalidia marginata* (Lep.)
-R.Gadagkar and N.V.Joshi
Anim.Behav. 31, 26-31 (1983)

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-R.Gadagkar, M.Gadgil, N.V.Joshi and A.S.Mahabal
Proc.Ind.Acad.Sci. (Animal Sciences)91, 539-552 (1982)

27. A Comparative Study of Social Structure in Colonies of Ropalidia
-R.Gadagkar and N.V.Joshi
Proc. IX Congress of IUSSI, 187-191 (1982)

28. When a Wasp Colony Splits
-R.Gadagkar and N.V.Joshi
Proc.IX Congress of IUSSI, 213 (1982)

29. Behaviour of the Indian Social Wasp Ropalidia cyathiformis (Fab.) on a Nest of Seperate Combs
-R.Gadagkar and N.V.Joshi
J.Zool (London) 198, 27-37 (1982)

Climatology

30. Coherent rainfall zones of the Indian region
-Sulochana Gadgil, Yadumani and N.V.Joshi
Int.J.Climatol. (1993, in press)

31. Ocean-Atmosphere Coupling over Monsoon Regions
-S.Gadgil, P.V.Joseph and N.V.Joshi
Nature 312,141-143 (1984)

32. Climatic Clusters of the Indian Region
-S.Gadgil and N.V.Joshi
J.Climatology 3, 47-63 (1983)

Molecular Biophysics

33. Theoretical Studies on ß-Lactam Antibiotics : Conformational Analysis of Penicillin Sulfoxides and Cephalosporins
-N.V.Joshi and V.S.R.Rao
J.Biosci.4, 209-218 (1982)

34. Flexibility of the Pyranose Ring in the a- and ß-D- Glucopyranoses
-N.V.Joshi and V.S.R.Rao
Biopolymers 18, 2993-3004 (1979)

35. Theoretical studies on ß -Lactam antibiotics : conformational flexibility of the five-membered ring in clavulanic acid and the binding specificity of ß-Lactamases
-N.V.Joshi, R.Virudachalam and V.S.R.Rao
Curr.Sci. 47,933-936 (1978)

General

36. Origin and Evolution of Life (four chapters)
- Bharati Sarkar, R. Gadagkar , N.V. Joshi and H. Sharat Chandra in the Textbook of Biology for class XII by NCERT , New Delhi 1989

37. Workshop on Frontiers of Evolutionary biology
-N.V.Joshi
J.Sci.Ind.Res. 42,659-662 (1983)

II. Technical Reports

38. A simulation model for human resource use
 - Yadumani, Gadgil M., Gadgil S. and Joshi N.V.
 C.E.S. Technical Report No. 58 , (1990)

39. Computer simulations for the Workshop on Conservation Biology
 -N.V.Joshi
 C.E.S. Technical Report No.44, (1987)

40. Reproductive competition and behavioural caste differentiation in the neotropical wasp Polistes versicolor
 - R. Gadagkar and N.V.Joshi
 C.E.S. Technical Report No. 41 , (1986)

41. Cluster Analysis of Rainfall Stations of Karnataka
 -S.Gadgil, S.Bagavant, N.V.Joshi and L.M.Hedge
 Report Published by the Bureau of Economics and Statistics, Govt. of Karnataka, Bangalore, India (1982)

42. Evolution of social behaviour : A primer
 - Madhav Gadgil, N.V.Joshi, R.Gadagkar, V. Nanjundiah and S.Gadgil
 Mimeograph (unpublished) , (1979)

III. Conference Presentations

43. Struction and dynamics of tropical deciduous forest in southern India
 -R.Sukumar, H.S.Suresh,H.S.Dattaraja and N.V.Joshi
 Indo-French workshop on Tropical Forest Ecosystems
 French Institute, Pondicherry, Nov. 1992

44. Evolution when there are two or more conflicting interests : some population genetic studies.
 -N.V.Joshi
 J.B.S.Haldane Centenary symposium of the Indian Academy of Sciences, held at Ahmedabad, Nov. 1992

45. Gene, Culture and Sexual Selection
 - N.V.Joshi and Vidyanand Nanjundiah
 Discussion Meeting on 'Genetic and Cultural Diversity in Human Populations, C.E.S. , I.I.Sc. , Bangalore , India Jan. 1991

46. Immunological Memory through complementary idiotypic interactions
 - R.Nayak and N.V.Joshi
 Symposium on 'Developemental Biology' at the 55th annual meeting Indian Academy of Sciences, Bhopal , India , Nov. 1989

47. Population genetic models for the spread of selfish DNA : Implications for sex determination
 - N.V.Joshi
 International Conference on Sex Determination and Dosage Compensation
 I.I.Sc. , Bangalore , India, Nov. 1989

48. Conservation Biology and the Asian elephant
 - R. Sukumar and N.V.Joshi
 V International Theriological Conference, Rome , Italy , August 1989

49. Disease causes chaos
- N.V.Joshi
Workshop on Chaos-Order-Catastrophe,
Max Mueller Bhavan/T.I.F.R., Bombay , India , Oct. 1987

50. Evolution of optimal sex ratios in social insects : Some mathematical models
- N.V.Joshi and R. Gadagkar
Fifth International Conference on Mathematical Modelling
University of California, Berkely, U.S.A. , July 1985

51. Pattern analysis in agrometeorology : theory and practice
- N.V.Joshi
Agrometeorology of Sorghum and Millet in the semi-arid tropics
ICRISAT/WMO preplanning meeting, Patancheru, India , Nov. 1982

52. Quantitative ethology of social wasps : Time-activity budgets and caste differention in Ropalidia Marginata
- R. Gadagkar and N.V.Joshi
Symposium on Ecology and Managment of Social Insects
U.A.S. , Hebbal, Bangalore , India , July 1981

53. Use of Principal Component Analysis in Rational Classification of Climates
-S.Gadgil and N.V.Joshi
Climate Classification : A Consultants' Meeting, ICRISAT, Hyderabad, India (1980)

PROFORMA

Name of the member of staff	**N.V. Joshi**
Designation	**Assistant Professor**
Department	**Centre for Ecological Sciences**
Age and Date of Birth	**45 Years, 14th December 1951**
Present Salary and Grade	**Rs. ~~4325~~ 4450 with effect from ~~January~~ 29-12 1996 in the grade Rs 3700-125-4950-150-5700**

1. DETAILS OF ACADEMIC QUALIFICATION (Degree onwards)

Examination	University/ Institution	Class obtained	Year of obtaining the degree
B.Sc.	Bombay University	First	1972
M.Sc.	I. I. T. Bombay	Second	1974
Ph.D.	I. I. Sc. Bangalore		1980

1.1 MEMBERSHIP OF PROFESSIONAL BODIES/ EDITORIAL BOARD MEMBERSHIP

Fellow, Indian Academy of Sciences.
Member, Editorial Board, *Current Science.*

2. DETAILS OF SERVICE AT THE INSTITUTE

Year From	To	Designation
		(At the Centre for Ecological Sciences)
29 Dec 1990	Present	***Assistant Professor***
18 Jul 1987	28 Dec 1990	***Lecturer***
		(At the Center for Theoretical Studies)
1 Dec 1983	17 Jul 1987	***Scientific Officer***
1 Dec 1978	30 Nov 1983	***Mathematical Programmer***

3. REPORT ON RESEARCH/TEACHING DURING THE PERIOD UNDER REVIEW

3.1.2 Sponsored Projects (Research Schemes)

Title	Multivariate Statistical Analysis of the Data Generated under the People of India Project.
Funding Agency	Anthropological Survey of India, Govt. of India.
Value	Rs. 12 lakhs (Rs. 1200,000)
Duration	Three Years (1993-1996)
Co-principal investigator	Shri Suresh Patil Anthropological Survey of India Southern Regional Centre, Mysore.

3.1.3 Publications (List attached)

At the time of last review	*During the period under review*
25 Published in journals	13 Published in journals
8 Presented at conferences	7 Presented at conferences etc.
	1 Submitted for publication
5 Technical reports	3 Book reviews
38 Total	24 Total

3.1.4 Brief Resume of Research Work Carried out During the Period under Review (Approximately 1000 Words)

The research work comprises of statistical analysis and mathematical modelling as applied to of ecology, anthropology and evolutionary biology. A brief description of the specific topics is given below. References cited in the text (in square brackets) refer to the items mentioned in the list of publications attached along with the report (Annexure I).

(i) Analysis of the Data from the '**People of India**' Project

The People of India (POI) project, carried out by the Anthropological Survey of India (AnSI) between 1985-1992 with the help of over 500 researchers identified and described the 2753 human communities of India. Along with the textual information running into over a hundred volumes, AnSI also compiled a data-set (computer-format-data), especially suitable for statistical analysis. This consisted of binary (presence/absence) records pertaining to the various 'traits' that characterize communities. The 776 traits covered diverse aspects of the communities such as history (e.g. whether the community has migrated to its present location), food habits (vegetarian/non-vegetarian), occupations (traditional and newly acquired), marriage practices (whether marrying one's mother's brother's daughter is prevalent), languages, educational status, access to developmental programs (availability of traditional/modern medicare), and so on. The Center for Ecological Sciences and the Anthropological Survey of India (and especially its Southern Regional Center) has set up a long-term collaborative program, beginning from 1992, for the statistical analysis of this rich dataset.

The initial phase consisted of reorganizing the data in a format suitable for checking and validation. A number of analyses were carried out for testing the internal consistency of the data which were helpful to the anthropologists for detecting and correcting some of the erroneous entries. Computation of the measures of similarity between specific pairs of communities provided a quantitative criterion for the anthropologists for deciding on the splitting and merging of communities. Subsequently, comprehensive state-wise as well as aggregate tables reporting the frequency distribution of the traits were prepared (for all the communities, as well as separately for the Scheduled Castes and Scheduled Tribes), which were released by the Anthropological Survey of India as an interim set of volumes titled 'People of India: A quantitative profile'. A preliminary analysis of the data brought forth several interesting features: the high diversity in the reported number of traits by the communities (low for primitive, island communities; high for Himalayan tribals), the high similarity between pairs of communities (56% compared to the expected 25%), the high correlations between traits, and so on [Joshi, 1992a].

The second phase involved a quantitative exploration of the data to examine the different aspects of the Cultural Diversity of the People of India. The concepts of alpha and beta diversity, as used in the standard ecological theory, were found to be particularly suitable for this analysis. An analogue of species-individual curve was seen when the number of communities were plotted against the populations of the different States/Union Territories (UTs) of India; a good straight-line fit for the log-log plot further suggested that the number of communities was proportional to the square-root of the population size. The departure from the predicted value (900) at the All India level from the observed (2753) could be explained in terms of high diversity across states/UTs. When the computed index of cultural similarity between states/UTs was used, along with the technique of multidimensional scaling, to represent them as points in a two-dimensional space, the influence of geographical proximity was clearly evident. Several other insights obtained from this investigation suggested that the analysis of anthropological data from an ecological perspective is likely to be a rewarding endeavor [Joshi, Gadgil and Patil, 1993].

Before launching on a detailed analysis of the patterns seen in the large number of traits in the POI data, it is desirable to examine a few of them, about which reliable information from other sources is already available. With this objective, the traits corresponding to the Desired Family Size (DFS) was investigated by computing their correlation with other traits. Based on a number of different criteria, a set of 30 traits emerged as associated with a high DFS (desiring four or more children); these were mainly indicative of communities low on a socioeconomic ladder (e.g., those practicing hunting, gathering and trapping of birds, those where child labour was prevalent etc.). On the other hand, 28 traits associated with low DFS (desiring one or two children) were indicative of highly educated urban and well-off rural communities. More importantly, this exercise suggested a composite economic index based on these 58 traits, which brought out intriguing differences between different religious groups of communities in their response (vis-a-vis DFS) to economic development [Joshi, Gadgil and Patil, 1996].

(ii) **Parent-Offspring and Offspring-Offspring Conflict in Plants**

The number of seeds in a fruit varies considerably across different species of plants. The 'optimal' number for a species results from a complex interplay of a variety of evolutionary interactions. Thus, a maternal parent's interest, for example, may be best served by an equitable distribution of the maternal resources amongst the progeny (seeds). On the other hand, an offspring would be better off with a larger-than-average share. A similar conflict over resources is present amongst siblings (say seeds within the same fruit). As a part of the ongoing collaborative program with K. N. Ganeshaiah and R. Uma Shaanker of the University of Agricultural Sciences, Bangalore on 'Plant Evolutionary Biology', these phenomena are being investigated using population genetic models.

For a diploid, panmictic and completely outbred population, the genetic relatedness between a parent-offspring pair is 0.5; so a seed is expected to evolve to usurp (according to Hamilton's rule) a higher share of resources till the benefit to it is higher than twice the cost to the maternal parent. In some species of plants, it is found that the maternal parent also (asexually) produces another embryo, which then would be related to it by unity. It was speculated that this phenomenon (Polyembryony) may have emerged as a counter-strategy of the maternal parent against the usurpation of its resources by the 'selfish' seed. Mathematical models set up to explore the evolution of polyembryony using the Evolutionarily Stable Strategies (ESS) criteria demonstrated that (i) polyembryony can evolve under maternal control for any 'clutch-size' but is unlikely to do so under offspring control for clutch size less than three; (ii) species more efficient in converting resources into fitness are more likely to evolve polyembryony and (iii) a higher level of outbreeding promotes polyembryony [Ganeshaiah, Uma Shaanker and Joshi, 1991].

When the evolutionary interactions between seeds within a fruit were modelled, it was seen that the intensity of conflict decreased with an increase in the seed number. Since such a conflict is absent in single seeded fruits, this result implies the highest level of conflict in species with two-seeded fruits , in turn suggesting that such species are likely to be less common than those with single-seeded or many-seeded fruits. This prediction is strikingly confirmed by empirical data, which shows a clear dip for two-seeded species in the curve showing the frequency distribution of species as a function of the number of seeds in a fruit [Joshi, 1992].

One of the consequence of such interactions is brood-reduction, whereby some of the seeds within a fruit abort during development. An analysis of the positional pattern of the surviving seeds in the pods of 'Erythrina suberosa' showed that seeds in adjacent positions are more likely to survive, indicating the presence of a positive 'neighbour effect' [Joshi, Uma Shankar and Ganeshaiah, 1993].

(iii) Analysis of **Vegetation Patterns**

To monitor the long-term dynamics of vegetation in a tropical moist deciduous forest, a 50 hectare plot has been set up in 1988 in the Mudumalai reserve forest in southern India by R. Sukumar of the Center for Ecological Sciences. All the trees whose diameter at the height of 1.3 m from the ground was greater than or equal to 1 cm were identified up to species level, and their spatial positions were recorded. The plot was monitored for survival and regeneration of trees every year, and for growth (change in diameter) in 1992. A preliminary analysis of spatial patterns (clumpiness, as characterized by the variance-to-mean ratio) of the nearly 25000 trees belonging to 71 species identified the various species that showed clumping at different spatial scales. The population declined by about 14% within two years, mainly due to the influence of fire and elephants [Sukumar, et. al., 1992].

An analysis based on the techniques of computational geometry (e.g. voronoi tessellation) showed a significant positive correlation between the area of the voronoi cell of a tree and the diameter of the tree. These investigations also suggested an objective and scale-independent index of aggregations, based on the distances to the Delaunay neighbours of the tree [Joshi, et al, submitted].

A comparison (based on the data obtained from thirty strip transects) between evergreen forest tracts in the Western Ghats (located in the Uttara Kannada district, South India), subjected to high and low levels of anthropogenic disturbances showed significant differences in their levels of alpha as well as beta diversities. Monte Carlo simulations, however, suggested that these could be attributable to the lower densities in the disturbed tracts. Statistical analysis demonstrated that the loss of several evergreen species (e.g. *Myristica malabarica*) from the more disturbed tracts was associated with the lack of coppicing ability in those species, coupled with their use in plywood/matchwood industries [Daniels, Gadgil and Joshi, 1995].

(iv) Analysis and Modelling of **Rainfall Data**

Based on the pairwise correlations between the interannual variations in the summer monsoon rainfall of 200 stations distributed across India, the country was divided into thirty coherent zones. The significant positive correlation seen between every pair of stations within a zone suggests that the regionalization obtained by the above method to be more appropriate for the study of rainfall patterns [Gadgil, Yadumani and Joshi, 1993].

The statistical formulation of the 'umbrella problem' was used to quantify the value of a correct prediction of an adverse meteorological event. This was applied to the case of groundnut farming in rain-fed regions of Karnataka. A knowledge of the cost of the mitigatory options, and of the crop losses if these options were not implemented could be used to estimate the minimum acceptable reliability of forecasts [Gadgil, et al, 1995].

(v) **Logic of the Genetic Code**

Since mutational events are likely to lead to changes in the amino acids, the present genetic code is likely to have evolved to minimize the possibility of disruptive changes. This premise can be used to determine the important properties of the amino acids - these would be the ones that are least affected by mutations. A markov model was set up to obtain 'genetic distances' between pairs of amino acids, based on the corresponding codons and a prespecified mutation rate. Its correlation with the 'physical property distance' between the same pairs identified the 'non-bonded interaction energy' as the most conserved property. The reliability and robustness of this inference was validated using a large number of simulated genetic codes [Joshi, Korde and Sitaramam, 1993].

(vi) Patterns of **Biological Diversity**

When the diversity of woody plant species in the Uttara Kannada district was compared to the diversity of its bird species (obtained using the data from 58 strip transects), a statistically significant negative correlation was obtained. This was explainable in terms of the relatively low number of bird species in the small, spatially isolated evergreen forests rich in plant species [Daniels, Joshi and Gadgil, 1992].

Based on the data on the distribution of species of vertebrates (mammals, birds, reptiles and amphibians) in over 60 countries across the world, avian diversity was shown to be a better indicator of the vertebrate diversity of a country. Patterns of distribution of endemism suggested that endemic diversity of one taxon (e.g. mammals) is more highly correlated with the endemic diversity of other taxa (e.g., reptiles) - the correlation in fact being higher than, for example, between the total number of reptile species and the number of endemic reptile species [Joshi, manuscript in preparation].

[Much of the work described above was *interdisciplinary in nature*, and was carried out in collaboration with: Suresh Patil, Madhav Gadgil, R. Uma Shaanker, K.N. Ganeshaiah, R. Sukumar, R.J. Ranjit Daniels, Sulochana Gadgil and V. Sitaramam.]

3.2 TEACHING

3.2.1 Courses Taught

A two credit, 200 level course titled *'Population Theory'* was taught in the August-December semester of 1993, 1995 and 1996.

3.2.5 Teaching in Workshops/Training Programs

Participated as a resource faculty in the following training programs organized at the Center for Ecological Sciences for the

- Indian Administrative Service Officers (1992)
- Indian Forest Service Officers (1993)* Scientists from the Botanical and Zoological Surveys of India (1995)
- Researchers and Students of Behavioural Ecology (1996)

4. SERVICES PROVIDED

These have been mainly towards setting up facilities related to the use of the internet, and advising colleagues and students on using them in a profitable manner. More specifically :

(i) Set up a world-wide-web site for the Center for Ecological Sciences, and maintained it for many months. Also provided advise on setting up of websites to several other departments in the Institute.

(ii) Have been maintaining a web-site for the journal 'Current Science', which displays the contents page as and when the issue is released.

(iii) Participated in organizing the anonymous FTP site at the Center for Ecological Sciences, and in acquiring and distributing public domain software relevant towards academic activities and scientific computing.

(iv) Helped some of the other departments in the institute in setting up and running e-mail servers.

5. Work Done for the Faculty/Senate and Other Academic Activities

5.1 In the Institute

(i) Officiated as the chairman of CES on many occasions, for periods ranging from several days to several months.

(ii) Senate Nominee on the Board of Examiners for the comprehensive examination for students from the Molecular Biophysics Unit and the Department of Physics.

(iii) Member of the selection committee for recruiting project staff (Centre for Atmospheric Sciences, Molecular Biophysics Unit, Application of Science and Technology to Rural Areas).

(iv) Member of the evaluation committee for the evaluation of the Watch and Ward employees (1994-1996), and Gardeners (1996).

(v) Participated in the evaluation of answer-papers for the entrance examination conducted by the Institute for admissions for research.

(vi) Advising on matters related to statistical analysis to colleagues and students from other departments in the Institute (Molecular Biophysics Unit, Department of Microbiology and Cell Biology, Department of Chemical Engineering, Center for Atmospheric Sciences, Department of Biochemistry).

(vii) Convener of the Departmental Curriculum Committee

5.2 Interactions with Other Organizations

(i) Member of the committee for the evaluation of scientist for
Salim Ali Center for Ornithology and Natural History, Coimbatore.
Center for Mathematical Modelling and Computer Applications, Bangalore.

(ii) Thesis examiner for
University of Agricultural Sciences, Bangalore (M.Sc, Ph.D.)
Goa University (Ph.D.)
Jawaharlal Nehru University (Ph.D.)
Wildlife Institute of India (Saurashtra University) (M.Sc.)

(iii) Setting up and evaluation of question papers for
Salim Ali School of Ecology, Pondicherry University (M.Sc.)

(iv) A series of lectures on '*Mathematical Modelling in Biology*' was given to the students of M.Sc. Biotechnology, University of Poona.

(v) Reviewing of manuscripts for
Current Science
Journal of Genetics
International Journal of Climatology
Journal of Biosciences

8. FUTURE PLANS

RESEARCH

The emphasis would be on the continuation of the on-going long-term projects.

(i) The analysis of the People of India data would be continued so as to explore patterns in other set of traits (e.g., those associated with the use of natural resources). Secondly, the recently acquired information on the spatial distribution of the various human communities would be analysed - e.g., to investigate the cultural correlates that characterize large and widespread communities which distinguish them from small, localized ones. Thirdly, using the techniques of a cluster analysis an attempt will be made to classify the 2753 Indian communities into distinct groups, using a variety of criteria. This exercise, together with the information on the location of the communities, should lead to a spatial profile of the cultural diversity of the people of India.

(ii) Techniques of spatial autocorrelation analysis will be employed to investigate the distribution of different tree species in the 50 hectare plot, with a view to understand their mortality and regeneration patterns. Similar techniques would be employed to examine the patterns of co-variation in other taxa (birds, butterflies) on a larger spatial scale (such as the Western Ghats). These data-analytic studies would be complemented by theoretical ones, which would be set up to obtain estimates of the gamma diversity of a region, under a variety of conditions corresponding to different functional forms characterizing the relationship between the level of beta diversity between two locations and the distance separating them.

(iii) Statistical analysis in community ecology normally begins with a species X localities matrix, where each element corresponds either to abundance, or 1/0 indicating presence/absence. This is followed by ordination, which enables representation of the data as points (species or localities) in a one, two or three dimensional space. Alternatively, species-specific parameters such as niche width and niche overlap are extracted from the original data by a variety of mathematical techniques. Attempt will be made to use a combination of the two approaches. A higher dimensional representation, together with the use of concepts from computational geometry (such as voronoi hypervolumes) is likely to lead to a more appropriate measure of niche width. It is also proposed to develop a representation of locations not as just points, but as a continuous distribution in a multidimensional hyperspace, such that peak height would be proportional to the alpha diversity at the location, and the overlap integral of two distributions would be inversely related to the beta diversity, i.e., proportional to the number of species shared by the two localities. It is hoped that this more realistic representation would provide better insights into the distribution of biodiversity of the region under investigation.

(iv) Apart from the above mentioned major projects, other, relatively recently initiated studies (mathematical modelling of the spread of rinderpest and PPRV in cattle, sheep and goat system; studies on the evolution of the genetic code including the information from the PAM matrices and the differential mutation rates of the bases; investigations of the movement patterns of plant tendrils) would also be continued in the coming years.

Teaching

Attempts will be made to develop and use software for training students of ecology in quantitative methods. One such set of computer programs (developed for demonstrating the relative efficiencies and accuracies of the different sampling techniques used in plant community ecology, and appreciated by the participants of several workshops) would be enhanced (by taking advantage of the increasing power and falling prices of personal computers) by including additional features such as animation. It is also planned to use the new World-wide-web based intra-net technology to develop a set of applets for training biology students in the use of statistical methods. This should make it easy for students to learn about the appropriate statistical tests to be applied for the data of their interest, at any time of the day or night, without the presence of the instructor. Being modular in nature by design, this collection can be easily and continuously improved, based on the feed-back from the students, which would be in the form of e-mail. It is felt that using such methods would constitute an effective use of the excellent computer network (and network-literacy) at the Indian Institute of Science.

Annexure I

List of Publication for the Period under Review

(i) **Published in Journals**

1. N.V. Joshi (1990). Transposable element-mediated evolution of sex : A population genetic model. *Journal of Genetics*, **69**, 127-139.

2. K.N. Ganeshaiah, R. Uma Shaanker and N.V. Joshi (1991). Evolution of polyembryony : Consequences to the fitness of mother and offspring. *Journal of Genetics*, **70**, 103-127.

3. N.V. Joshi and Madhav Gadgil (1991). On the role of refugia in harvesting biological populations. *Theoretical Population Biology*, **40**, 211-229.

4. R.J. Ranjit Daniels, Malati Hegde, N.V. Joshi and Madhav Gadgil (1991). Assigning conservation value: A case study from India. *Conservation Biology*, **5**, 464-475.

5. R. Sukumar, H.S. Dattaraja, H.S. Suresh, J. Radhakrishnan, R. Vasudeva, S. Nirmala and N.V. Joshi (1992). Long-term monitoring of vegetation in a tropical deciduous forest in Mudumalai, southern India. *Current Science*, **62**, 608-616.

6. R.J. Ranjit Daniels, N.V. Joshi and Madhav Gadgil (1992). On the relationship between bird and woody plant species diversity in the Uttara Kannada district of south India. *Proc. Natl. Acad. Sci. USA*, **89**, 5311-5315.

7. N.V. Joshi (1992). Sibling rivalry between seeds within a fruit : Some population genetic models. *Journal of Genetics*, **71**, 105-119.

8. N.V. Joshi, Uma Shankar and K.N. Ganeshaiah (1993). The 'neighbour effect' and its role in shaping the positional pattern of seed development in fruits: an illustration from the pods of *Erythrina suberosa*. *Current Science*, **65**, 234-238.

9. N.V. Joshi, Madhav Gadgil and Suresh Patil (1993). Exploring cultural diversity of the people of India. *Current Science*, **64**, 10-17.

10. Sulochana Gadgil, Yadumani and N.V. Joshi (1993). Coherent rainfall zones of the Indian region. *Int. J. Climatol.*, **13**, 547-566.

11. N.V. Joshi, Vivek V. Korde and V. Sitaramam (1993). Logic of the genetic code: Conservation of long-range interactions among amino acids as a prime factor. *J. Genet.*, **72**, 47-58.

12. R.J.R. Daniels, Madhav Gadgil and N.V. Joshi (1995). Impact of human extraction on tropical humid forests in the Western Ghats in Uttara Kannada, South India. *J. Appl. Ecol.*, **32**, 866-874.

13. N.V. Joshi, Madhav Gadgil and Suresh Patil (1996). Correlates of the desired family size among Indian communities. *Proc. Natl. Acad. Sci. USA*, **93**, 6387-6392.

(ii) **Conference/Seminar/Symposia Presentations**

14. A. Chandrasekar, Suresh Patil and N.V. Joshi (1996). Cultural Correlates of Tribes in Andhra Pradesh Seminar on *'Ethnic Situation in India: Fields and Frontiers'*. Anthropological Survey of India, Mysore, India

15. R. Sukumar, H.S. Suresh, H.S. Dattaraja and N.V. Joshi (1995). Dynamics of a tropical deciduous forest: Population changes during 1988-1993 in a 50 ha plot at Mudumalai, southern India. Conference on *'Measuring and Monitoring Forest Biological Diversity'*. Smithsonian Institution, U.S.A.

16. Sulochana Gadgil, P.R. Sheshagiri Rao, N.V. Joshi and S. Sridhar (1995). Forecasting rain for groundnut farmers - How good is good enough?. Workshop on *'Climatic Variability of South Asia and its impact on Agriculture'*. Indian Institute of Science, Bangalore, India.

17. N.V. Joshi (1992a). Analysis and interpretation of the data 'Meeting on the Analysis and Interpretation of the Data Generated by the People of India Project'. Institute for Social and Economic Change, Bangalore, India.

18. N.V. Joshi (1992b). Evolution when there are two or more conflicting interests: Some population genetic models. *'J.B.S. Haldane Centenary Symposium'* of the Indian Academy of Sciences, Physical Research Laboratory, Ahmedabad, India.

19. R. Sukumar, H.S. Suresh, H.S. Dattaraja and N.V. Joshi (1992). Structure and dynamics of tropical deciduous forest in southern India. Indo-French workshop on *'Tropical Forest Ecosystems'*. French Institute, Pondicherry, India.

20. N.V. Joshi and Vidyanand Nanjundaiah (1991). Gene, culture and sexual selection. Discussion meeting on *'Genetic and Cultural Diversity in Human Populations'*. Indian Institute of Science, Bangalore, India.

(iii) **Manuscript Submitted**

N.V. Joshi, H.S. Suresh, H.S. Dattaraja and R. Sukumar. The spatial organization of plant communities in a deciduous forest: A computational geometry based analysis.

(iv) **Others (Book Reviews)**

Review of 'Green Business Opportunities'
N.V. Joshi (1996). *Current Science*, **70**, 250.

Review of 'Mathematical Evolutionary Theory' (ed. M.W. Feldman)
N.V. Joshi (1994). *Journal of Genetics*, **73**, 77-83.

Review of 'Teaching of Mathematical Modelling and Applications'
N.V. Joshi (1993). *Journal of the Indian Institute of Science*, **73**, 545-547.

(v) **Manuscripts under Preparation**

Correlates of dowry and bride-wealth in the Indian communities
Suresh Patil, N.V. Joshi and Madhav Gadgil

Drongos in the mixed feeding flocks
Lalitha Vijayan, N.V. Joshi and Madhav Gadgil

Estimating the number of unseen species: Some mathematical models
N.V. Joshi, R.J. Ranjit Daniels, A.P. Gore, A.V. Kharshikar and Madhav Gadgil

Global patterns of vertebrate diversity
N.V. Joshi

ANNEXURE II

LIST OF PUBLICATIONS AT THE TIME OF LAST REVIEW

(i) **In Journals/Books Etc.**

THEORETICAL BIOLOGY

21. N.V. Joshi (1988). Evolution of polyandry by reduction in progeny number variance in structured populations. *Journal of Genetics*, **67**, 161-171.

22. N.V. Joshi (1987). Evolution of co-operation by reciprocation within structured demes. *J. Genetics,* **66** , 69-84.

23. N.V. Joshi (1987). Testing sex ratio theory within social insects. In: *Chemistry and Biology of Social Insects*, J. Eder and H. Rembold (Eds.) , Verlag J. Peperny, Munchen, pp. 343-344.

24. N.V. Joshi (1987). Kin recognition, polygamy and the sex ratio. In *Chemistry and Biology of Social Insects*, J. Eder and H. Rembold (Eds.), Verlag J. Peperny, Munchen, pp. 481.

25. N.V. Joshi (1986). Evolution of sex ratios in social Hymenoptera : Consequences of finite brood size. *J. Genetics*, **65** , 55-64.

26. N.V. Joshi and R. Gadagkar (1985). Evolution of sex ratios in social Hymenoptera: Kin selection, local mate competition, polyandry and the sex ratio. *J. Genetics*, **64** , 41-58.

27. M. Gadgil, M. Hedge, N.V. Joshi and S. Gadgil (1985). On the communication of well-being. *Proc. Ind. Acad. Sci. (Animal Sciences)*, **94**, 575-586.

28. S. Sinha, N.V. Joshi, J. Subba Rao and S. Mookerji (1984). A four-variable model for the pattern forming mechanism in hydra. *Biosystems*, **17**, 15-22.

29. M. Gadgil, N.V. Joshi and S. Gadgil (1983). On the moulding of population viscosity by natural selection. *J. Theor. Biol.*, **104**, 21-42.

30. R. Gadagkar, V. Nanjundaiah, N.V. Joshi and H. Sharat Chandra (1982). Dosage compensation and sex determination in Drosophila: Mechanism of measurement of the X/A ratio. *J. Biosciences*, **4**, 377-390.

31. R. Gadagkar, V. Nanjundaiah, N.V. Joshi and H. Sharat Chandra (1981). Measurement of the ratio of X-Chromosomes to sets of Autosomes in *Drosophila melanogaster. Curr. Sci.*, **50**, 805-807.

32. R.J.R. Daniels, N.V. Joshi and M. Gadgil (1990). Changes in the bird fauna of Uttara Kannada in relation to changes in land use over the past century. *Biological Conservation*, **52**, 37-48.

33. R. Sukumar, N.V. Joshi and V. Krishnamurthy (1988). Growth in the Asian elephant. *Proceedings of the Indian Academy of Sciences (Animal Sciences)*, **97**, 561-571.

34. R. Gadagkar and N.V. Joshi (1985). Colony fission in a social wasp. Curr. Sci., **54**, 57-62.

35. R. Gadagkar and N.V. Joshi (1984). Social organization in the Indian wasp *Ropalidia cyathiformis. Z. Tierpsychol*, **64**, 15-32.

36. R. Gadagkar and N.V. Joshi (1983). Quantitative ethology of social wasps : Time-activity budgets and caste differentiation in *Ropalidia marginata* (Lep.). *Anim. Behav.*, 31, 26-31.

37. R. Gadagkar, M. Gadgil, N.V. Joshi and A.S. Mahabal (1982). Observations on the natural history and population ecology of the social wasp *Ropalidia marginata. Proc. Ind. Acad. Sci. (Animal Sciences)*, **91**, 539-552.

38. R. Gadagkar and N.V. Joshi (1982). A comparative study of social structure in colonies of *Ropalidia. Proc. IX Congress of IUSSI*, 187-191.

39. R. Gadagkar and N.V. Joshi (1982). When a wasp colony splits. *Proc. IX Congress of IUSSI*, 213.

40. R. Gadagkar and N.V. Joshi (1982). Behaviour of the Indian social wasp *Ropalidia cyathiformis* (Fab.) on a nest of separate combs. *J. Zool.* (London), *198*, 27-37.

Climatology

41. S. Gadgil, P.V. Joseph and N.V. Joshi (1984). Ocean-atmosphere coupling over monsoon regions. *Nature*, **312**, 141-143.

42. S. Gadgil and N.V. Joshi (1983). Climatic clusters of the Indian region. *J. Climatology*, **3**, 47-63.

43. N.V. Joshi and V.S.R. Rao (1982). Theoretical studies on ß-Lactam antibiotics : Conformational analysis of Penicillin Sulfoxides and Cephalosporins. *J. Biosci.*, **4**, 209-218.

44. N.V. Joshi and V.S.R. Rao (1979). Flexibility of the Pyranose ring in the α- and ß-D- Glucopyranoses. *Biopolymers*, **18**, 2993-3004.

45. N.V. Joshi, R. Virudachalam and V.S.R. Rao (1978). Theoretical studies on ß -Lactam antibiotics : Conformational flexibility of the five-membered ring in clavulanic acid and the binding specificity of ß-Lactamases. *Curr. Sci.*, **47**, 933-936.

(ii) **Conference Presentations**

46. R. Nayak and N.V. Joshi (1989). Immunological memory through complementary idiotypic interactions. Symposium on '*Developemental Biology*' at the 55th annual meeting Indian Academy of Sciences, Bhopal , India.

47. N.V. Joshi (1989). Population genetic models for the spread of selfish DNA: Implications for sex determination. International Conference on '*Sex Determination and Dosage Compensation*' at I.I.Sc., Bangalore , India.

48. R. Sukumar and N.V. Joshi (1989). Conservation biology and the Asian elephant. V International *Theriological Conference*, Rome , Italy.

49. N.V. Joshi (1987). Disease causes chaos. Workshop on '*Chaos-Order-Catastrophe*', Max Mueller Bhavan/T.I.F.R., Bombay, India.

50. N.V. Joshi and R. Gadagkar (1985). Evolution of optimal sex ratios in social insects : Some mathematical models. Fifth International Conference on '*Mathematical Modelling*', University of California, Berkely, U.S.A.

51. N.V. Joshi (1982). Pattern analysis in agrometeorology: Theory and practice. '*Agrometeorology of Sorghum and Millet in the semi-arid tropics*' ICRISAT/WMO preplanning meeting, Patancheru, India.

52. R. Gadagkar and N.V. Joshi (1981). Quantitative ethology of social wasps : Time-activity budgets and caste differentiation in *Ropalidia marginata.* Symposium on '*Ecology and Management of Social Insects*', U.A.S., Hebbal, Bangalore , India.

53. S. Gadgil and N.V. Joshi (1980). Use of principal component analysis in rational classification of climates. '*Climate Classification : A Consultants' Meeting*', ICRISAT, Hyderabad, India.

(iii) Technical Reports

54. Yadumani, M. Gadgil, S. Gadgil and N.V. Joshi (1990). A simulation model for human resource use. *C.E.S. Technical Report* No. 58.

55. N.V. Joshi (1987). Computer simulations for the Workshop on Conservation Biology. *C.E.S. Technical Report* No.44.

56. R. Gadagkar and N.V. Joshi (1986). Reproductive competition and behavioural caste differentiation in the neotropical wasp *Polistes versicolor. C.E.S. Technical Report* No. 41.

57. S. Gadgil, S. Bagavant, N.V. Joshi and L.M. Hedge (1982). Cluster analysis of rainfall stations of Karnataka. *Report* Published by the Bureau of Economics and Statistics, Govt. of Karnataka, Bangalore, India.

58. Madhav Gadgil, N.V. Joshi, R. Gadagkar, V. Nanjundiah and S. Gadgil (1979). Evolution of social behaviour : A primer. *Mimeograph* (unpublished).

(iv) Others

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