

Bangalore  
19/8/94

To,  
Prof. Jagdish  
ASTRA  
IISc. Bangalore 560 012.

Dear Sir,

Kindly refer to your advertisement R(VIIA)FRLH--1/308-63/94 for the post of Project Associate in your Department. I wish to apply for the same and I am enclosing my bio-data for your perusal. I hope you will consider my application favorably.

Thanking you,

Yours faithfully

Vidya S. Swamy.  
(Dr. MRS. VIDYA. S. SWAMY)

## CURRICULUM VITAE

NAME : Dr. (Mrs) VIDYA SHIVA SWAMY  
DATE OF BIRTH : 4th January 1948  
NATIONALITY : Indian  
ADDRESS : 444, 1st Main  
3rd Cross Rajeswari Nagar  
BEML Layout, Bangalore-560 039.

### ACADEMIC QUALIFICATIONS :

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Degree	Subjects	Grade
B.Sc. 1968 Osmania University	Botany, Zoology Chemistry	II Class
M.Sc. 1970 Osmania University	Zoology (Helminthology)	I Class
Ph.D. March 1976 Osmania University	Nematology Title of the thesis : Systematic studies on soils and plant parasitic Nematodes of Ornamental plants.	

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**RESEARCH EXPERIENCE :** Working as a research associate in the Department of Biochemistry, Indian Institute of Science from June 1978 with Dr.T. Ramasarma and Dr.C.K.R. Kurup. Later joined Dr.C.S. Vaidyanathan's laboratory from 1988 April. Work in different projects were undertaken and a short resume of the work is enclosed.

## RESUME OF RESEARCH WORK

### DRUGS AND THERMO REGULATION

In this project the emphasis was laid on the thermoregulatory mechanisms operating in the rat and effect of drugs and super imposed stress was studied. Chlorpromazine treated rats become hypothermic when exposed to cold stress (0-4°C). This hypothermia was reversed by prior treatment with adenosine compounds showing the involvement of purinergic nervous system in thermoregulation.

Our results with heat stress showed that the  $\alpha$ -receptors are blocked with phenoxybenzamine treatment and the animals become hyperthermic and lose their ability to dissipate heat, Prochlorperazine (another commonly used phenothiazine) also induces hyper-thermia under heat stress in rats. This hyperthermia is abolished when animals are prior treated with paracetamol, a serotonin synthesis inhibitor.

### OXIDATIVE METABOLISM IN RAT KIDNEY MITOCHONDRIA IN HEAT STRESS

Eventhough basically heat exposure and starvation necessitate lowering of BMR. the effects of the two treatments produce on mitochondrial oxidation in kidney and rat liver are different. Heat exposure lowers the rate of state 3 oxidation in both kidney and liver mitochondria to the same extent. The decrease in the content of mitochondrial cytochrome C also follows the same pattern in the two organs. However the fall in oxidation is corrected by exogenous cytochrome c only in

kidney mitochondria. We find that added cytochrome c does not stimulate respiration in mitochondria from liver of this animals in contrast the decrease in the respiratory rate shown by liver mitochondria of starved animals is corrected by exogenous cytochrome c. However this pigment fails to simulate, the lowered respiratory rate of kidney mitochondria of starved animals, eventhough there is decrease in cytochrome c in both the organelles. A regulatory role for cytochrome c in mitochondrial oxidative phosphorylation under stress conditions by these results is indicated.

#### VANADIUM AND CALCIUM INTERACTION

Treatment of animals with sodium vanadate alters the calcium homeostasis of the animal. There is a three fold increase in the calcium concentration in the plasma. The hepatic mitochondria exhibited enhanced uptake of calcium after vanadate treatment. There is also an enhanced rate of  $H_2O_2$  generation and increase in  $\alpha$ -Glycerophosphate dehydrogenase activity in the hepatic mitochondria of vanadate treated rats. Our work shows that vanadate may have  $\alpha$ -adrenergic mimetic action.

#### Fe<sup>+</sup> INDUCED LIPID PEROXIDATION IN MITOCHONDRIA

Addition of  $FeSO_4$  (5-25  $\mu M$ ) to mitochondria or sonic submitochondrial particles induced uptake of oxygen several times in excess of the reducing capacity of  $Fe^{2+}$  in the absence of any exogenous oxidizable substrate or organic chelating agent like ADP. The O:Fe ratio ranged from 5 to 8. During the reaction,

thiobarbituric acid reacting material was produced indicating peroxidation of lipids. Oxidation (state 3) of  $\text{NAD}^+$  - linked substrate was more sensitive to inhibition by lipid peroxidation than was of succinate. The reaction did not adversely affect  $\text{Ca}^{2+}$  -stimulated oxygen uptake and the energy-linked uptake of ( $^{45}\text{Ca}$ ) by mitochondria. This is the first report of a novel phenomenon.

#### EFFECT OF MIC ON MITOCHONDRIAL RESPIRATION

In rabbits administered MIC subcutaneously the hypoxia was shown to be stagnant type. Having ruled out that MIC interaction with Hb molecules does not play a role in the production of hypoxia in mammals, we extended our investigations to find out whether MIC could induce histotoxic hypoxia as well through its effect on mitochondrial respiration.

Administration of  $1.0 \text{ LD}_{50}$  methylisothiocyanate (MIC) s.c. resulted in the stimulation of state 4 respiration, abolition of respiratory control, decrease in ADP/O ratio and inhibition of state 3 respiration with  $\text{NAD}^+$  - linked substrate (glutamate + malate) while with succinate as substrate, there were no adverse effects of the parameter studied. Further studies are in progress to delineate clearly the specific effect of MIC at lethal concentrations on mitochondrial respiration.

## EFFECT OF HEAT SHOCK ON BHK 21 CELLS

When BHK 21 cells were subjected to heat stress (50°C for 10'). It was seen that a single protein of 80,000 mol.wt was expressed in the cytosol. There was no change in microsomal enzymes but the  $\alpha$ -glycerophosphate dehydrogenase in mitochondria was decreased by 50%. It was surprising to note that there was no detectable NADH oxidase activity in mitochondria though the dehydrogenase was present.

## REGENERATION OF CITRUS PLANTS BY TISSUE CULTURE

We have successfully regenerated plantlets of Citrus aurantifolia (Rough Lemon) through Tissue Culture techniques. Right now we are doing field trials of these plants.

## BIOCHEMICAL STUDIES ON BROWN BAST DISEASE IN RUBBER

We have done extensive studies on biochemical changes in latex of Hevea brasiliensis affected by brown bast disease. We have found out that <sup>there</sup> are many changes in the latex biochemistry but one of the striking changes is the expression of the enzyme Diphenyl oxidase in the brown bast affected trees only. We have used this as a marker for the diagnosis of the onset of the disease and have also prepared a diagnostic strip which will positively indicate the onset of the disease. We have also standardised the RIA technique for the estimation of the phytohormone, Zeatin in the rubber latex. We have done exhaustive work on the C<sup>14</sup> acetate incorporation and have found that there is a substantial increase in the phosphatidic acid content in the rubber latex in the brown bast affected trees.

## BIOCHEMICAL CHANGES IN JASMINE DURING FLOWERING.

This project was sponsored by DST We have identified two proteins which were induced during flowering. viz., glucose -6-phosphate dehydrogenase, and cytokinin binding protein. We have found that Jasmine produces phytic acid in large quantities, which makes protein identification a formidable task. Our studies have shown that cytokinin binding proteins are expressed in all parts of the plant.

## TECHNIQUES VERSED WITH

Chromatography, Electrophoresis, Spectroscopy, HPLC, Isotope labelling, Histology - Histocheistry, Microscopy, Manometric techniques, Organic Synthesis, Enzyme purification, Morphology Systematics, Chemotaxonomy, Animal Tissue Culture and Plant Tissue Culture, Radiomuroassay, Molecular biology techniques

Papers Published 17

Papers under preparation - 2

Projects handled - 3. (DST, Rubber board, UGC)

Centre for Ecological Sciences  
Indian Institute of Science  
Bangalore 560 012

12 July, 1996

To

The Chairman  
Centre for Ecological Sciences  
Indian Institute of Science  
Bangalore 560 012

Dear Dr. Gadagkar,

I was glad to learn that the Centre for Ecological Sciences (CES) was planning to induct new faculty members in the near future. My happy association with you and the department now prompts me to apply for a faculty position at CES. I enclose, with this letter, a copy of my curriculum vitae and a statement of research objectives for your consideration. I look forward to hearing from you.

Thank you very much.

With my best wishes and sincere regards,

*Anindya Sinha*  
Anindya Sinha

Encl.:

1. Curriculum vitae
2. Research objectives
3. Reprints of publications

## CURRICULUM VITAE

### ANINDYA SINHA

Research Associate  
Centre for Ecological Sciences  
Indian Institute of Science, Bangalore, India

#### Office:

Centre for Ecological Sciences  
Indian Institute of Science  
Bangalore 560 012, India  
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#### Residence:

44/1, Nandidurga Road  
"Ramya Royal", Ground Floor  
Bangalore 560 046, India  
Telephone: (91-80)-3430147

#### Place and date of birth:

Calcutta, India - October 1, 1960

### EDUCATION

- Tata Institute of Fundamental Research, University of Bombay  
PhD in Molecular Biology (1985-1990)  
March 1993
- University of Calcutta  
MSc in Botany, with specialisation in Cytogenetics (1983 - 1985)  
May 1985
- University of Calcutta, Presidency College  
BSc in Botany (Honours), Zoology and Chemistry (1979 - 1982)  
March 1983

### SCHOLARSHIPS, AWARDS AND HONOURS

- National Prize, Secondary School Examinations, 1977
- National Talent Scholarship, 1977 - 1985
- National Scholarship, BSc, 1982
- University Gold Medal for Botany, BSc, 1982
- J. C. Nag Memorial Medal, Presidency College, 1982
- University Gold Medal for Botany, MSc, 1984
- Hiranath Memorial Medal, Botanical Society of Bengal, 1984

12/02/1992

PUNE - 16

TO,

DR. SULOCHANA GADGIL

CENTRE FOR ECOLOGICAL AND ATMOSPHERIC STUDIES,  
INDIAN INSTITUTE OF SCIENCE

BANGALORE - 560012.

RESPECTED MADAM,

I, RAJEEV SHARMA, IS DOING M. PHIL IN THE DEPARTMENT OF PHYSICS, UNIVERSITY OF POONA, PUNE-7, IN THE FIELD OF ATMOSPHERIC PHYSICS. I HAVE PASSED M.Sc. WITH DISTINCTION IN ENVIRONMENTAL SCIENCE FROM THE SAME UNIVERSITY IN 1990. I HAVE QUALIFIED FOR GATE-1990 (SCORE 92.11) AND UGC LECTURERSHIP EXAMINATION IN DEC. 1989.

I AM INTERESTED TO CONTINUE MY EDUCATION IN THE SAME FIELD. IN THIS REGARD I WOULD BE GRATEFUL IF YOU CAN PROVIDE AN OPPORTUNITY TO WORK WITH YOU IN ANY RELATED PROJECT..

I AM ENCLOSING A COPY OF MY BIODATA FOR YOUR KIND CONSIDERATION.

IN THE HOPE TO GET A POSITIVE REPLY.

YOUR'S SINCERELY,

RS Sharma

[ RAJEEV SHARMA ]

C/O MR. S.D. KELKAR

'SUDARSHAN'

1102/B/1, LAKAKI ROAD,

MODEL COLONY

PUNE - 411016

To,

Dr. N. V. JOSHI  
Centre for Ecological Sciences,  
Indian Institute of Science  
BANGALORE - 560012.

Dear Sir,

Received your letter and noted the contents. I have enclosed my biodata along with this letter for your reference. Sir, If you feel that my qualifications can fetch any post in your institute under your guidance, please do reply. Please excuse me for troubling you in this regard.

With best regards,

June 25, 1992  
Cochin.

Yours sincerely,  
Dr. Shivaraj K.M.

Dr. K. M. Shivaraj  
Project Scientist-  
R. NO. 216, P.O. Box 2704  
CMFRZ, COCHIN - 682031.

Nandakumar. U.N.,  
Silviculturist,  
Kerala Forest Research Institute,  
Peechi, Trichur - 680 653.

19-11-1992.

To

Dr. JOSHY,  
Centre for Ecological studies,  
IISc, BANGALORE.

Dear Sir,

Hope this will find you in good health and cheers. Here my works are progressing well. I am interested to apply for this years Ph.D programme (External Registration). I hope Centre for Ecological Studies has already cleared the proposal for taking students for the Ph.D programmes through external registration. I would like to know all the details with regard to this years programme. If necessary, I can come to Bangalore so that we can discuss other formalities in detail.

I would like to have one more information. During one of our discussion with a World Bank official recently with regard to my ongoing project on Multitier Forestry he was suggesting me to take experimental plots on different locations. He was also mentioning about the studies on similar lines being carried out by Dr. Ravindra Nath. I would like to know its present position. Now where is Dr. Ravindra Nath? Has he come back after his sabbatical leave? I am sure, you must also be involved in this project. If viable, we can make it into a good collaborative programme. What is your suggestion in this regard? Our Director is also interested in having a collaborative study. He has asked me to get further details.

Here with regard to my project, the first phase is almost complete and I am now busy with the finalisation of the report. The initial part is mainly to establish a Demonstration Plot. In the next phase, as mentioned in our discussion, my plan is to develop a decision support system. Now, with the help of Dr. P.V. Vijayakumaran Nair, I am trying to use GIS to study the stand dynamics of the plot. Currently I am having data of five time points starting from the initiation of the activity. More over data collection for developing a silvicultural knowledge base has also progressed to a considerable extent. Now Dr. Nair is on a field tour for two weeks to Trivandrum.

My sister - in - law, who was doing Post - Doctoral work at IISc has joined Cochin University as a Lecturer, at the Biotechnology centre.

Kindly convey my regards and respects to Prof. Nanjundaih,  
Prof. Subramaniam, Prof. Gadekar, and Prof. Gadgil.

awaiting reply,

with warm regards,

Yours Sincerely,



(U.N. NANDAKUMAR)

5.6.93,  
Vijayawada.

Respected Joshi garu,

Srinivas namaskarams to you.

Hope, this letter finds you in good health.

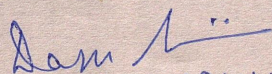
Here, I am fine. Hope, you recieved my previous letter.

I think, Dr. Murthy, had E-mailed to you. In my previous letter, I wrote about my brother (Mr. D.R.K. Mohan) who wants to join in the Institute. If possible kindly suggest him for any project fellow ~~is~~ Sir. I am sending his BIO-DATA along with this letter to you. Please, do consider him Sir.

Here, In Vijayawada it is too hot and we are facing severe summer. Kindly, do reply to me.

Thanking you, Sir,

yours faithfully,

Dam   
(CDASU SRINIVAS)



## RESEARCH EXPERIENCE

- *Classical, biochemical and molecular genetics of carbohydrate metabolism in yeast*  
(August 1985 - September 1990)

My doctoral work for a degree in Molecular Biology involved the isolation and the subsequent biochemical and genetic characterisation of mutants of the yeast, *Saccharomyces cerevisiae*, affected in the normal functioning of the pentose phosphate pathway. This study included developing strategies for the selection of mutants, genetic manipulation of such strains (involving genetic crosses and tetrad analysis), and fluorimetric enzyme assays. In course of this work, I was able to discover a novel gluconolactone-metabolising route in this organism and later investigated the operation and inducibility of this pathway.

As part of this research, I also examined the levels of transcription of a gene coding for a particular enzyme, 6-phosphogluconate dehydrogenase, involved in the pentose phosphate pathway. This allowed me to gain experience in the methods of molecular biology, including the isolation and restriction-mapping of DNA, polyacrylamide and agarose gel electrophoresis, subcloning of DNA into yeast-bacteria shuttle plasmids, and Southern and Northern blot analysis.

- *Sociobiology, ethology and population genetics of social wasps*  
(January 1991 - February 1993)

With my first postdoctoral fellowship, I investigated the social behaviour and colonial organisation of two species of tropical, primitively eusocial, polistine wasps, *Ropalidia rufoplagiata* and *Ropalidia marginata*. The former, studied by our group for the first time, appears to be unique amongst all primitively eusocial wasps in exhibiting a temporal differentiation of reproductive labour but possibly completely lacking a permanent reproductive caste. My research into the sociobiology of *R. marginata* focussed on various aspects of its social behaviour including the mechanisms underlying reproductive competition, the development of dominance behaviour and rank hierarchies, regulation of worker activity, and kin discrimination.

The techniques employed in these studies primarily involved behavioural observations using various sampling methods and the statistical analysis of the sociobiological data obtained. We also performed a series of manipulative experiments on colonies of *R. marginata* in order to investigate (1) patterns of inter-individual dominance during founding and mature phases of the colony cycle, and (2) the ability of adult wasps to recognise unrelated conspecifics even in the absence of important motivational factors, such as the nest.

During the course of this work, I also carried out a preliminary analysis of allozyme polymorphisms in local populations of *Ropalidia marginata*. Approximately 60 - 80 individuals were examined for allelic variation in the loci coding for the enzymes: invertase, esterase, amylase, acid- and alkaline-phosphatases, by activity-staining of cell-free extracts in polyacrylamide gels. Significant variation could be detected, however, only in the case of esterase (three loci; three alleles at one polymorphic locus, the other two monomorphic).

□ *Sociobiology, communication and cognition in primates*  
(March 1993 - present)

My second postdoctoral fellowship allowed me to investigate social relationships and social cognition in two free-living troops of the bonnet macaque, *Macaca radiata radiata*. This study has thrown light on two inter-related problems of primate sociobiology: (1) individual- and sex-specific strategies employed in the development and maintenance of social relationships and (2) cognitive processes that underlie social decision-making.

My research on the macaques has primarily involved field observations on the ecology and demography of the study troops, development of a detailed ethogram for the species, observational sampling of and data collection on individual behaviour patterns and their sociometric analysis.

□ *Establishment of a Molecular Ecology and Population Genetics Laboratory*  
(March 1996 - present)

I am currently engaged in setting up a molecular ecology and population genetics laboratory at the Centre for Ecological Sciences, Indian Institute of Science, Bangalore. This laboratory will use molecular genetic approaches to investigate a number of problems related to the behavioural ecology and conservation biology of several social mammalian species including the lion-tailed macaque, the Asian elephant, the Asiatic wild dog and the Indian one-horned rhinoceros.

#### **TEACHING EXPERIENCE**

I have had extensive, though informal, teaching experience at the graduate and undergraduate level. This has mainly stemmed from being actively involved in guiding summer- and other temporary trainees, both at the Molecular Biology Unit, Tata Institute of Fundamental Research (TIFR), where I completed my doctorate, and at the Centre for Ecological Sciences, Indian Institute of Science (IISc), where I have worked subsequently.

My experience has primarily been in teaching basic molecular biology, genetics, animal behaviour and evolutionary biology, sampling techniques, statistical analysis, use of personal computers and statistical software, and writing of technical reports. I have also been involved in formal teaching (series of a few lectures on specific topics) during training programmes for doctoral students both at the Molecular Biology Unit, TIFR (neurobiology) and at the Centre for Ecological Sciences, IISc (molecular genetics, conservation biology).

In addition, I was a member of the teaching faculty at the Workshop on Methods in Behavioural Ecology, organised by Dr. Raghavendra Gadagkar at the Centre for Ecological Sciences, Indian Institute of Science, Bangalore, in October 1992.

## PARTICIPATION IN MEETINGS

### A. Workshops

1. International Workshop on Yeast Molecular Biology, organised by the European Biochemical Society, Jerez de la Frontera, Spain, September 1987
2. Workshop on Topics in Evolutionary Biology, organised by the Centre for Theoretical Studies, Indian Institute of Science, Bangalore, India, December 1989
3. National Workshop on Statistical Methods for Ecologists, organised by the Department of Statistics, Pune University, Pune, India, December 1991
4. Workshop on Methods in Behavioural Ecology, organised by the Centre for Ecological Sciences, Indian Institute of Science, Bangalore, India, October 1992
5. Hands-on Training Course in DNA Fingerprinting, organised by the Centre for Cellular and Molecular Biology, Hyderabad, India, January - February 1996

### B. Conferences

1. Mahabaleshwar Seminar on Modern Biology - Transposable Genetic Elements, organised by the Ahmadnagar College and Molecular Biology Unit, Tata Institute of Fundamental Research, Mahabaleshwar, India, October 1985
2. First International Conference on Neurobiology of Sensory Systems, organised by the Molecular Biology Unit, Tata Institute of Fundamental Research, Goa, India, September 1988
3. Discussion Meeting on Learning and Memory, organised by the Centre for Ecological Sciences and University of Agricultural Sciences, Heggedihalli, India, June 1991
4. Discussion Meeting on Cell Biology, organised by the Developmental Biology and Genetics Laboratory, Indian Institute of Science, Bangalore, January 1993
5. Discussion Meeting on Evolutionary Biology, organised by the Developmental Biology and Genetics Laboratory, Indian Institute of Science, and Mangalore University, Mangalore, December 1995
6. Discussion Meeting on Directed Mutation, organised by the Indian Academy of Sciences, Bangalore, March 1996

## PUBLICATIONS

### A. Research papers

1. A. SINHA AND P. K. MAITRA, 1992. Induction of specific enzymes of the oxidative pentose phosphate pathway by glucono- $\delta$ -lactone in *Saccharomyces cerevisiae*. *Journal of General Microbiology*, **138**: 1865-1873
2. A. SINHA AND K. CHANDRASHEKARA, 1992. Some like it hot... A reply to Wehner, Marsh and Wehner. *Nature*, **359**: 593
3. A. SINHA, S. PREMNATH, K. CHANDRASHEKARA AND R. GADAGKAR, 1993. *Ropalidia rufoplagiata*: a polistine wasp society probably lacking permanent reproductive division of labour. *Insectes Sociaux*, **40**: 69-86
4. A. SINHA, 1994. A search for non-oxidative pentose phosphate pathway mutants in *Saccharomyces cerevisiae*. *Journal of Genetics*, **73**: 65-79
5. S. PREMNATH, A. SINHA AND R. GADAGKAR, 1995. Regulation of worker activity in a primitively eusocial wasp *Ropalidia marginata*. *Behavioural Ecology*, **6**: 117-123
6. A. SINHA, 1995. Whose life is it anyway? A review of some ideas on the issue of animal rights. *Current Science*, **69**: 296-301
7. S. PREMNATH, A. SINHA AND R. GADAGKAR, 1996. Dominance relationships in the establishment of reproductive division of labour in a primitively eusocial wasp (*Ropalidia marginata*). *Behavioural Ecology and Sociobiology*, in press
8. A. SINHA, 1996. Complex tool manufacture by a wild bonnet macaque, *Macaca radiata*. *Folia Primatologica*, in press

### B. Conference proceedings and book chapters

1. S. PREMNATH, A. SINHA AND R. GADAGKAR, 1994. Dominance behaviour and the resolution of intra-colonial conflicts in the primitively eusocial wasp, *Ropalidia marginata*. In: *Les Insectes Sociaux (Abstracts of the 12th Congress of the International Union for the Study of Social Insects)* (eds. A. Lenoir, G. Arnold and M. Lepage), Universite Paris Nord, Paris, p. 242
2. S. PREMNATH, A. SINHA AND R. GADAGKAR, 1996. How is colony activity regulated in *Ropalidia marginata*. In: *Readings in behaviour* (eds. R. Ramamurthy and Geethabali), New Age International Publishers, New Delhi, pp. 160-167

3. A. SINHA, 1996. A new twist in an old macaque tale: Allogrooming relationships among wild female bonnet macaques. Abstract at the *16th Congress of the International Primatological Society*, to be held at Madison, Wisconsin, USA, August 1996

#### **C. Technical reports and research reviews**

1. A. SINHA, 1992. The strange case of the naked mole-rat. *Current Science*, **63**: 540-541
2. A. SINHA, 1993. Molecular genetics of social wasps: a case study. In: *Methods in Behavioural Ecology* (ed. R. Gadagkar), Technical Report No. 24, Centre for Ecological Sciences, Indian Institute of Science, Bangalore, pp. 259-261
3. A. SINHA, 1995. Driven up the tree: Why do wild dogs harass leopards? *Current Science*, **69**: 903
4. A. SINHA, 1996. An empirical framework for the study of primate consciousness. *NIAS News* **5**: 22-24

#### **D. Book reviews**

1. A. SINHA, 1993. Beyond Natural Selection: a review of the book by Robert Wesson, MIT Press, 1992. *Journal of the Indian Institute of Science*, **73**: 163-164
2. A. SINHA, 1996. In Quest of the Sacred Baboon: A Scientist's Journey: a review of the book by Hans Kummer, Princeton University Press, 1995. *Current Science*, **70**: 1101-1102

#### **E. Submitted papers**

1. A. SINHA. Knowledge acquired and decisions made: Triadic interactions in wild bonnet macaques, *Macaca radiata*. Submitted to *Philosophical Transactions of the Royal Society, London*

#### **OTHER ACADEMIC QUALIFICATIONS**

1. Guest editor of the Special Section on Animal Welfare, *Current Science*, **69**, 1995, pp. 296-316

## REFERENCES

1. Pabitra Kumar Maitra  
Agharkar Research Institute  
Adarkar Road  
Pune 411 004, India
2. Obaid Siddiqi  
Molecular Biology Unit  
Tata Institute of Fundamental Research  
Bombay 400 005, India
3. Richard W. Byrne  
Scottish Primate Research Group  
University of St. Andrews  
School of Psychology  
Fife KY16 9JU, United Kingdom
4. Dorothy Cheney  
Department of Biology  
University of Pennsylvania  
Philadelphia, PA 19104, United States of America
5. M. K. Chandrashekar  
Jawaharlal Nehru Centre for Advanced Scientific Research  
Jakkur  
Bangalore 560 064, India
6. K. VijayRaghavan  
National Centre for Biological Sciences  
TIFR Centre, PO Box 1234, IISc Campus  
Bangalore 560 012, India
7. Ramesh Maheshwari  
Department of Biochemistry  
Indian Institute of Science  
Bangalore 560 012, India

## RESEARCH OBJECTIVES

ANINDYA SINHA

In the coming years, I would like to focus my research interests on two broad areas, namely: (A) sociobiology, cognition and phylogenetics of Indian primates and (B) behavioural ecology and conservation genetics of some endangered Indian mammals. Some of the possible projects in these areas that I am interested in developing are briefly discussed below:

### **A. SOCIOBIOLOGY, COGNITION AND PHYLOGENETICS OF INDIAN PRIMATES**

#### *(1) Sociobiology and genetics of bonnet macaques*

For the past three years, I have been working on social relationships and reproductive strategies in wild bonnet macaques (*Macaca radiata radiata*). This study has documented a diversity of individual behavioural strategies in the complex social life of these primates.

An important component that should be measured in any evolutionary study is individual fitness, for this provides a clue to the nature of selective forces that act on individuals following particular life-history strategies. In newly-initiated studies on nonhuman primates, the measurement of direct and indirect fitness invariably becomes a problem since genealogies are seldom discernible. DNA fingerprinting and other associated molecular techniques can, however, provide a fairly elegant solution to this problem; such experimental techniques can not only answer questions on parental identity (and hence, allow us to measure individual fitness), but also provide information on genetic relatedness (and hence, reproductive patterns) within and between groups of individuals.

In continuation of my research, therefore, I would like to determine parentage and explore levels of genetic relatedness in my two study troops which have exchanged males in the immediate past, and further evaluate the development of social relationships in these troops against the background of their genetics.

#### *(2) Social cognition and communication in bonnet macaques*

Have the remarkable complexity of social relationships in the macaque troops and the tremendous behavioural flexibility of each individual that form these relationships selected for the evolution of cognitive abilities? My study has so far provided evidence for at least one important aspect of social cognition among adult bonnet macaques: social knowledge. Individuals appear to be aware not only of the dominance ranks and the allogrooming relationships of their troop members, but also take social decisions on the basis of this knowledge.

Future investigations would focus on other aspects of social cognition, including interindividual communication, that may have evolved to enhance an individual's ability to handle simultaneous social relationships, each different from the other. From the viewpoint of individual selection, such cognitive faculties may also include social manipulation, deception and other innovative complex behaviours that provide an individual with an increasing diversity of potentially competitive social strategies.

### *(3) Evolution of social behaviour in bonnet macaques*

There are two subspecies of the bonnet macaque: the northern *M. radiata radiata*, widely distributed over peninsular India north of the state of Tamil Nadu, and *M. radiata diluta*, found exclusively in the two southern-most states of India: Tamil Nadu and Kerala. Although the social system of the *radiata* subspecies is typically cercopithecine in that the females are philopatric while males usually leave their natal troops to join other groups, unpublished reports suggest that the southern *diluta* subspecies is completely different in exhibiting male philopatry and female emigration.

It would, therefore, be of tremendous interest to explore the evolution of this social divergence of the two subspecies, which are otherwise so similar as to warrant them positions within the same species group. What are the ecological factors that have demanded such a remarkable divergence when the two subspecies separated? Are there corresponding changes in patterns of interindividual relationships that would promote and support such different social systems? Are there zones of hybridisation between these two subspecies? What would be the nature of these hybrid populations if at all they exist? These questions could be investigated by observational field studies, with support from molecular genetic data on populations of these two subspecies.

### *(4) Sociobiology and phylogenetics of the Indian macaques*

The genus *Macaca*, with 14 - 16 species distributed across North Africa and Asia, is the most diverse of the cercopithecine primates. India is unique in being home to seven of these macaque species. With the notable exception of the rhesus (*Macaca mulatta*), the lion-tailed (*M. silenus*) and the bonnet macaques, however, none of the other Indian macaque species have been studied so far in the wild. These include the Assamese (*M. assamensis*), the stumptailed (*M. arctoides*) and the pigtailed (*M. nemestrina*) macaques of the northeastern Indian states and the crab-eating macaque (*M. fascicularis*) of the Nicobar islands in the Bay of Bengal.

The moist deciduous and the evergreen forests of the northeastern states and the mangrove vegetation of the Nicobar islands, which form the habitat for these macaques, are extremely threatened environments. Consequently, populations of these primates have significantly reduced in the past years, and all the four species have been declared to be highly endangered. It has thus become imperative to not only study the behaviour, population dynamics and biogeography of these species, but also to describe the distribution

of genetic variation within and among the natural populations of each of these species. I would be extremely interested to use molecular data to reconstruct the genetic and evolutionary relationships among populations and between species of these Indian macaques. These phylogenies would be very useful in examining the evolution of various morphological and behavioural traits (particularly those relating to social behaviour and individual reproductive strategies) in these populations. Another important use of such reconstructed phylogenies would be in defining the smallest units of conservation within each species, a subject that is now receiving increasing attention.

## **B. BEHAVIOURAL ECOLOGY AND CONSERVATION GENETICS OF ENDANGERED INDIAN MAMMALS**

Experimental investigations into the population genetics of wildlife species are almost completely absent in India. There are no laboratories which use molecular techniques to research into these areas. The importance of such studies, on the other hand, can hardly be understated, especially for a country like ours, teeming with natural resources.

If given an opportunity, I would like to establish a molecular ecology and population genetics laboratory which would employ molecular genetic techniques to examine a range of problems in behavioural ecology and evolutionary biology, as well as in biodiversity conservation and management. Some specific research problems that could be investigated in the proposed laboratory are briefly listed below. It must be stressed, however, that these are only representative problems in these important, yet neglected, areas of research, and do not necessarily signify a complete set of problems that this laboratory would address.

### *(1) Problems in population genetics and conservation biology*

In conservation biology, most discussions of genetics have focussed on how best to preserve genetic variability within threatened species, the assumption being that higher genetic variation enhances the probability of a population's survival over ecological or evolutionary time. Although a subject of considerable debate, this assumption has directly led to a spurt of studies that have focussed on the determination of basic population parameters such as effective population size, population substructure and the effects of low genetic variability in small and fragmented populations of endangered species of plants and animals.

So far, there have been virtually no attempts to investigate genetic variability (including such associated parameters as levels of heterozygosity and inbreeding) in any plant or animal taxon endemic to India or in those facing an urgent need of conservation. Such knowledge would be vital in tackling a variety of problems in conservation biology including, for example, defining the smallest genetic units for conservation, devising preservation strategies *in situ*, or planning translocation of individuals across variously skewed populations. I would now like to undertake detailed population studies of certain endangered or threatened mammalian taxa including the Asian elephant (*Elephas maximus*), the Indian one-horned rhinoceros (*Rhinoceros unicornis*) and the different species of the Indian macaques.

Although this laboratory would initially focus on Indian mammals, it is envisaged that other endangered species of plants and animals could subsequently be investigated with the purpose of documenting genetic variation in populations of these species. Data, thus obtained, can then be used to help design management strategies for the species in question in order to conserve the greatest amount of genetic diversity possible. The extreme urgency for this kind of research in a country threatened with a slow, but gradual, loss of biodiversity can only be understated.

(2) *Problems in behavioural ecology and evolutionary biology*

A fundamental concept in evolutionary biology is inclusive fitness. Behavioural ecologists have long assumed that individual organisms should try to direct altruistic behaviour only to their genetic relatives. Testing the various predictions which follow from this assumption requires accurate knowledge about genetic relationships. Multilocus minisatellite DNA fingerprinting (and various newly-developed alternative techniques including the use of a series of highly polymorphic specific minisatellite or microsatellite loci) now provides a powerful method to verify genetic relationships among individual animals and plants studied in the field. Such data, in turn, can be used to complement data on social behaviour of individuals in studies directed towards understanding social relationships and the evolution of social life, mate choice and sexual selection, and a host of related problems in sociobiology.

In this area of research, I would be particularly interested in investigating genetic relatedness in social groups and individual fitness measures that result from natural alternative reproductive strategies in social species such as the Asian elephant and the Asiatic wild dog (*Cuon alpinus*). Genetic studies of this kind, it is hoped, would complement and extend the research programs that are already being conducted at the Centre for Ecological Sciences over the past years.

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