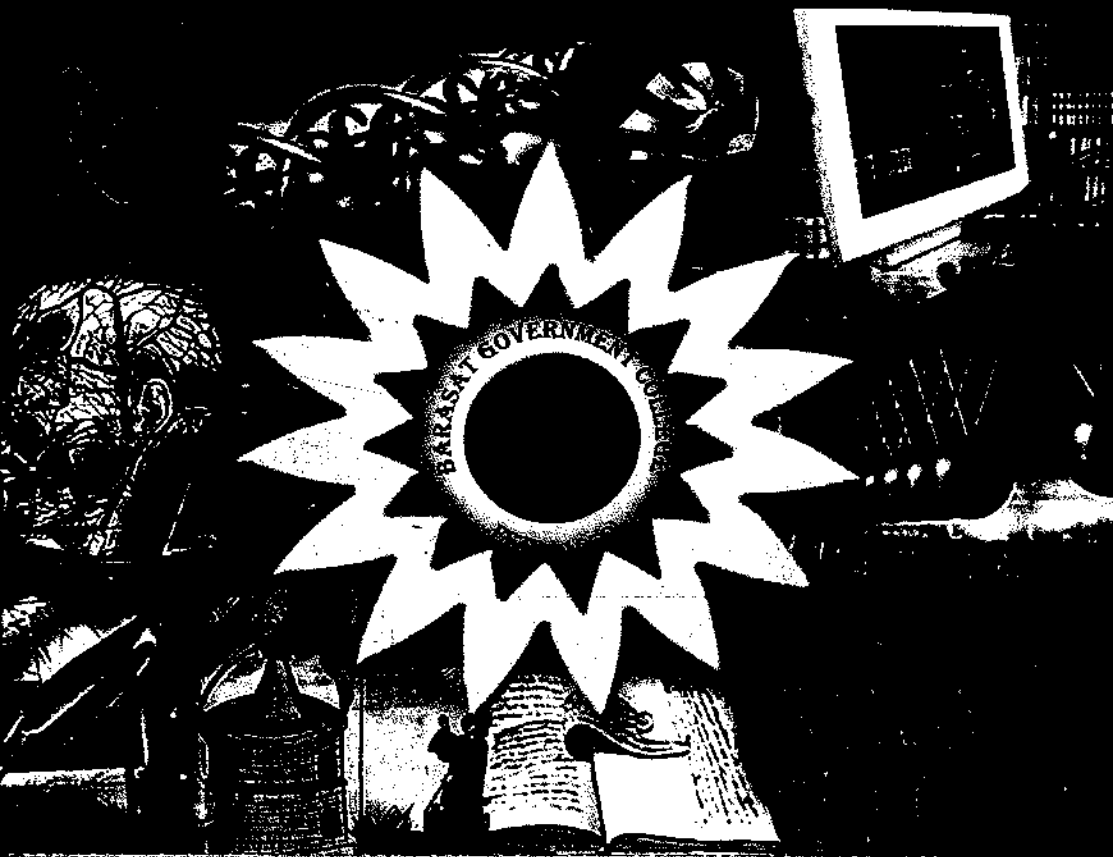


ISSN 0976 - 9625

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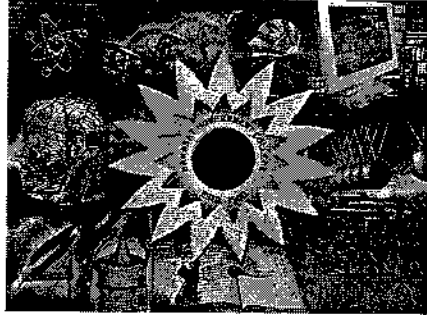
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Published by Barasat Government College

2011

AUREOLE



An Academic Journal

(ISSN 0976-9625)



AUREOLE - An Academic Journal (ISSN 0976 - 9625)
A Publication in Humanities, Science and Social Science

Present Issue:

Volume 3; Number 1

Published on 30th June, 2011

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ISSN 0976 - 9625 of this Journal is assigned by
**The National Institute of Science Communication and
Information Resources, India**

Typeset & Printing :

J P Pandey, RN-13/ 5 /C, Raghunathpur (N), Kolkata - 700059

Published in West Bengal, India by

Barasat Government College, Kolkata 700124, West Bengal

AUREOLE - An Academic Journal : ISSN 0976-9625

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EDITORIAL

It gives me immense pleasure to publish the third volume of the journal 'Aureole'. Publication of a journal covering a wide area of pure and social science with articles in considerable depth, yet accessible to all levels of readers, is a matter of pride. The journal has been recognized by the National Institute of Science Communication and Information Resources, India. Now-a-days we observe tremendous growth in various fields of science and technology, knowledge is expanding in a very rapid manner, the life style of common people has changed a lot and as a result of all this the world appears to be small, though there is inequilibrium between the ways and means, the way we intend to publish the journal and the way it is actually published. We deeply feel and aware that we are to go miles...

But it is very inspiring that the journal has already occupied a place in its allied academic domain and we strongly believe that it will further assert itself in the coming days. Special thanks to the members of the Advisory Board and other learned Referees who have reviewed the articles and extended valuable support before bringing out this issue. Despite our sincere efforts, some mistakes may creep in - I would remain responsible for all such errors.

Dr. Prabir Kumar Das

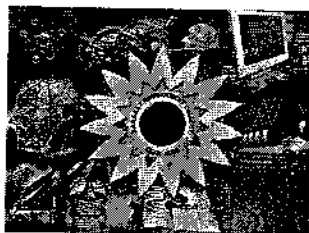
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ACADEMIC JOURNAL AUREOLE

30th June, 2011

AUREOLE

An Academic Journal
(ISSN 0976-9625)



VOLUME 3

June 2011

NUMBER 1

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Studies on the suppression of Immune Cells in a Model of Psoriasis Pathogenesis

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Abstract

Psoriasis is a disease that appears as scaly red lesions on human skin. Earlier the disease has been adjudged to be caused by ingredients external to human body. But, with the progress of clinical research, the disease has been found to be due to imbalances in human immune system. Cell biological research on the disease observed that immune cells such as helper T-cells and dendritic cells are central to disease pathogenesis and the same has been identified as synonymous to hyperproliferation of epidermal keratinocytes. Scaliness of psoriatic plaques has been attributed to excessive generation of nitric oxide through a complex chain of bio-chemical events. A density type mathematical time differential model for the disease has been proposed earlier. Immunosuppressive drugs, as observed by clinical findings, are probable treatment for psoriasis. We consider selective suppression of T-cells within the mathematical model and study its effects with an eye to gain understanding about treatment therapy for the disease. Results from our analysis are consistent with existing clinical findings and emphasizes possible ways of systematic therapy to alleviate the disease.

Key words : Pathogenesis, Immune cells, Density model, Immunosuppressive drugs, Systematic treatment therapy

1. Introduction

The disease psoriasis is manifested as inflammation of skin which appears as scaly red lesions on the skin surface known as plaques. Earlier it has been perceived that the disease had its root external to the human body. However, clinical research later recognized the disease to be caused due to some imbalances in the human immune system. Psoriasis affects approximately 2 - 3% of the world population and is abundant in the Asian subcontinent. Although the exact mechanism leading to the disease is yet to be fully understood, it is established by clinical and cell biological research that various genetic, environmental and immunological factors contribute to the pathogenesis of the disease. As emphasized by clinical and cell biological research, Psoriasis is characterized by T-cell mediated hyperproliferation of keratinocytes [1].

Changes in the epidermis are the most striking feature of Psoriasis, which led to the earlier hypothesis that it is entirely a skin disease having its root to the epidermal area of the skin. But today Psoriasis is recognized as the most prevalent autoimmune disease caused by inappropriate activation of the cellular immune system[2]. Detailed

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mechanism leading to the pathogenesis of the disease is fairly complex where immune cells and their environment play well coordinated roles [3-5]. Let us consider the sequence of events or processes leading to the disease in a brief submission. The epithelial cells of the skin are hyperproliferative and fail to undergo normal differentiation, leading to a marked thickening of the epidermis [1], a dramatic increase in the number and size of blood vessels situated just below the epidermis takes place and abscesses composed of neutrophils form within the epidermis. Psoriatic skin is characterized by dense infiltrate of T-cells and cells of innate immune system including neutrophils, dendritic cells, macrophages and Natural Killer T-Cells (NKT). In the current understanding of psoriasis pathogenesis, IFN- γ produced by a category of T-helper cells (Th1) and TNF- α produced by variety of cell types, have central roles in the disease state. This view is supported by numerous studies that show high levels of IFN- γ & related proteins and TNF- α within lesional skin [6]. Scientific researches in the allied area highlight that IL-23, IL-17A and TGF- β are essential cytokines in psoriasis pathogenesis as in other inflammatory diseases [7]. Dendritic cells (DC) are also crucial to Psoriasis. As described by Lowers and

in the epidermal and dermal psoriatic lesions as compared to normal human skin. These cells expedite the process of DC maturation and the synthesis of the enzyme named inducible nitric oxide synthase (*i*-NOS), thereby increasing the level of TNF- α .

Actually, there happens to be a complex cytokine network that plays a crucial role in psoriasis in the process of mutual activation of T-cells and DCs and increasing the influx of these cells in the skin. It is observed that the organic components IL-23, IFN- γ , TNF- α are predominant in psoriasis where IFN- γ , central to Psoriasis because of the fact that lesions can be induced by intradermal injection of IFN- γ [9]. DCs and keratinocytes can produce various cytokines and chemokines. Again IFN- γ and TNF- α induce keratinocytes to produce IL-6, IL-8, IL-12, IL-18 etc. On the other hand IL-23, produced by activated DCs, stimulates Th-17 cells to produce IL-17A, IL-17F, IL-6, IL-22, TNF- α etc. IL-17A synergizes with IFN- γ to enhance IL-6 and IL-8 and thereby increases influx of T-cells in the skin. Thus cytokine network is central to Psoriasis and eventually becomes a self-sustaining process [1-9].

Taking clues from the above mentioned clinical and cell-biological evidence [1-6, 10-15], a basic density type model has been proposed for the disease Psoriasis [16]. In the model, hyperproliferation of keratinocytes has been emphasized as precursor to the psoriatic flakes and redness of scaly lesions of psoriatic plaques are assigned to be owing to excess production of nitric oxide in the affected skin through *i*-NOS pathway. Studies on the model revealed clear signatures of disease pathogenesis and detailed outcomes were seen to conform the till-date clinical and cell-biological findings.

Further evidence from clinical research, relating treatment of the disease Psoriasis, show that Immunosuppressive drugs Cyclosporin-A, when administered to the affected patients, leads to progressive suppression of the severity of the disease [3]. These immunosuppressive drugs actually inhibit T-cell proliferation and cytokine production and hence a consequent suppression of the disease pathogenesis occurs. Trials with anti-

CD4 monoclonal antibodies and IL-2-toxin conjugate have been observed to have positive response to cure Psoriatic lesions [4]. In short, drugs that suppress selective immune cells, in excess in the human blood, are helpful in treating the Psoriatic patients [17-19]. Keeping this in mind, we, in this paper, try to study the end effects of selectively suppressing T-cells [20, 21] in human blood within the framework of the mentioned basic density model of Psoriasis.

The paper is organized as follows. Section 1 consists of the introductory remarks with reference to existing ideas and facts in the literature relating disease pathogenesis in Psoriasis and a proposed basic density model for Psoriasis. In Section 2, the basic density model is being introduced with few fundamental results incorporated in Section 3. Inclusion of selective suppression of T-cells within the basic model is considered in Section 4. Discussions and Conclusions are penned in Section 5.

2. The Basic Density Model For Psoriasis

Mathematical modeling of psoriasis is considered based on the chain of cell biological events that precedes the occurrence of psoriatic plaques on human skin. In the way of framing the model, influence of cytokine network on the cell biological events, as described above, is incorporated. As a starting point of the modeling, let us consider $L(t)$, $M(t)$ and $K(t)$ to represent concentrations of T-cells, dendritic cells/macrophage and epidermal keratinocytes respectively at a specific time t . We make following assumptions to obtain a set of dynamical equations involving the lymphocytic T-cells, dendritic cells (macrophages) and keratinocytes that becomes the mathematical prototype of the disease.

- A1. We assume an influx of T-cells in the region proximity to the plaques at a constant rate a . A similar influx or accumulation of Dendritic cells (Macrophages) at the relevant region is also considered to be at a constant rate b .
- A2. To cohere to the essence of A1, it is assumed that T-cells and DCs are not reproduced in any form or by any mechanism and only constant accumulation or influx of them happen in the spatial region under consideration. Note here that tissue macrophages are derived mostly from $CD14^+$ and $CD16^+$ Monocytes [22].
- A3. We assume that stimulation/activation of T-cells and DCs take place in closed cyclic route. Such stimulation/activation is through the process of mutual interaction and is most effective under mixing homogeneity of the participating cells.
- A4. Activation of T-cells and DCs eventually add to the growth of keratinocytes in the epidermis through an intermediate chain of multifaceted biochemical events involving the complex cytokine network. Growth in $K(t)$ is proportional to the product of $L(t)$ and $M(t)$. The fractions of T-cells and DCs, taking part in the process of mutual activation, are assumed to be unavailable for further activation.

- A5. Per capita removal of T-cells and DCs through natural processes, denoted by $\mu(\in R_+)$ and $\mu'(\in R_+)$ respectively, are assumed. T-Lymphocytes, being suspended particles in the blood serum, have greater mobility than DCs which are basically tissue macrophages confined in dermal region. Consequently the condition $\mu < \mu'$ is enforced.
- A6. Large scale production of Nitric Oxide, through the *i*-NOS pathway, have been assumed and the same is at the cost of proliferated keratinocytes [23-26]. This inherently signifies a per capita loss of keratinocyte mass denoted by the parameter $\lambda(\in R_+)$.

The above assumptions lead to the following density differential equations for the progression of the disease psoriasis. These equations represent the basic model for psoriasis.

$$\begin{aligned} \frac{dL}{dt} &= a - \delta LM - \mu L \\ \frac{dM}{dt} &= b - \beta LM - \mu' M \\ \frac{dK}{dt} &= \eta LM - \lambda K \end{aligned} \quad \dots\dots\dots(1)$$

Where parameters δ = Rate of mixing of T-cells with their mutual counterpart DCs, β Rate of mixing of DCs with T-cells and η = Rate of growth of keratinocyte mass out of mutual activation of T-cells and DCs.

3. Studies on the Basic Model

To gain confidence about the model so formulated we carried on solving the model equations as a function of time by varying different model parameters. Time series solutions of the model equations, albeit numerically, show that asymptotically the stable solutions do exist in a wide domain of the parameter space. Specifically, the asymptotic solutions are always stable and single valued. Having found such characteristics of the asymptotic solutions of the model equations we can move to find analytic solutions for fixed value of model variables $L^* = L(t \rightarrow \infty)$, $M^* = M(t \rightarrow \infty)$, and $K^* = K(t \rightarrow \infty)$. Imposing the asymptotic stable and single valued characteristic of solutions, we get

$$\begin{aligned}
 0 &= a - \delta LM - \mu L \\
 0 &= b - \beta LM - \mu' M \dots\dots\dots \textcircled{2} \\
 0 &= \eta LM - \lambda K
 \end{aligned}$$

This set of equations is solved for L^* , M^* and K^* as functions of varying model parameters. Solutions of these equations yield

$$M^* = \frac{-(\mu\mu'+a\beta-b\delta) \pm \sqrt{(\mu\mu'+a\beta-b\delta)^2 + 4\mu\mu'b\delta}}{2\mu'\delta} \dots\dots\dots 3(a)$$

$$L^* = \frac{a}{\mu + \delta M^2} = \frac{b - \mu' M^*}{\beta M^*} \dots\dots\dots 3(b)$$

$$K^* = \frac{\eta L^* M^*}{\lambda} \dots\dots\dots 3(c)$$

Looking at the dynamical progression of time the series solutions as well as the numeric of their stable asymptotic values, the following defaults of model parameters are fixed as depicted below in Table-1. It is to be noted here that model variables L, M and K are considered to be in units of mm³ and in equation 3(a) only the positive solution for M^* is allowed.

Table-1: Default Values of Model Parameter

Parameter	Definition	Default Values
a	Rate of influx/accumulation of T-cells	15 mm ³ Day ⁻¹
b	Rate of influx/accumulation of DCs/Macrophages	15 mm ³ Day ⁻¹
δ	Rate of activation of T-cells by DCs	0.15 mm ³ Day ⁻¹
β	Rate of activation of DCs by T-cells	0.12 mm ³ Day ⁻¹
η	Growth rate of keratinocytes	0.35 mm ³ Day ⁻¹
μ	Per capita removal of T-cells	0.02 Day ⁻¹
μ'	Per capita removal of DCs	0.05 Day ⁻¹
λ	Decay rate of keratinocytes	0.08 Day ⁻¹

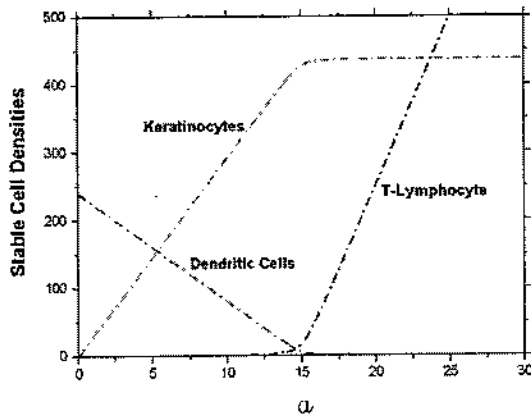


Figure 1: Plots of stable cell densities (L^* , M^* , K^*) as a function of parameter α , the rate of influx of T-cells. L^* , M^* , and K^* are calculated using Equations-(3). All other parameters are as in Table-1.

Analytic solutions for fixed values of model variables are explored with the variations of every single of the model parameters, while the rest of the parameters are assigned to their default values as in Table-1.

Fixed values of model variables (L^* , M^* , K^*) are plotted as a function of the rate of influx of accumulations of T-cells α in Figure-1. We find that for very small α , L^* and K^* are negligibly small but M^* is at its maximum. With the increase of α , DC/Macrophage stable values M^* degrades, the keratinocytes' density K^* rises almost linearly but rise in T-cell density L^* is negligible till a value of $\alpha \sim 15$, beyond which L^* shows a steep and linear rise. A little beyond the magic threshold $\alpha \sim 15$, K^* assumes saturation to a high numerical value.

A similar study on the variation of L^* , M^* , and K^* as a function of the parameter b , the rate of influx or accumulations of DCs/Macrophages, shows analogous behavior of all 3 variables as in the earlier case, however with flipped characteristics variation of L^* and M^* as compare to that as a function of α . Here the magic threshold for the varying parameter is $b \sim 12$, beyond which keratinocytes' density assumes saturations to $K^* \sim 435$.

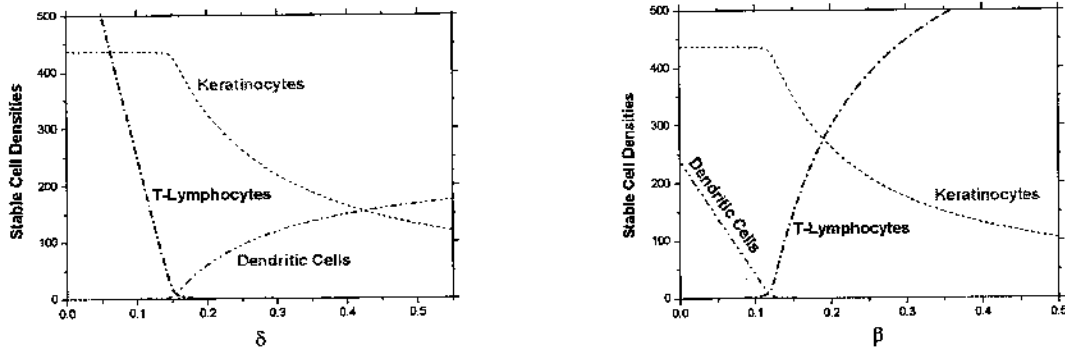


Figure 2: Plots of stable cell densities (L^* , M^* , and K^*) with varying δ (left panel) and varying β (right panel). In each case, parameters except the one varied, are assigned to their default values as in Table-1,

We further study the variation of L^* , M^* , and K^* as functions of the rate of activation of T-cells by DCs (δ) and rate of accumulations of DCs by T-cells (β). The plots are given in Figure-2. We find that with the increase of δ the lymphocytic T-cells density L^* registers drastic fall and becomes insignificant at a threshold value of $\delta_{th} \sim 1.6$. Beyond this threshold value, DCs density M^* gradually rises and keratinocytes' density K^* decreases monotonically before hitting a downgraded saturation level at $K^* \sim 120$. Variations of L^* , M^* , K^* with β shows again a threshold value of the parameter at $\beta_{th} \sim 1.1$, beyond which the DCs density is insignificant whereas T-cell density rises monotonically. Below the β_{th} , keratinocytes' density is at its saturation ($K^* \sim 435$) and beyond the β_{th} , K^* gradually decreases and hits a downgraded saturation $K^* \sim 100$ for large β .

4. Suppression of T-cells within the model

Existing therapies of treating the disease psoriasis incorporate applications of drugs like Cyclosporin-A and anti-CD4 monoclonal antibodies conjugated with IL-2 toxin [3, 4, 17-19]. These are the generic compounds known to be immunosuppressive, meaning that they inhibit T-cell proliferation and cytokine production [20, 21]. Being motivated by such clinical evidences we consider a suppression of T-cell influx within our model. The suppression can be included in the model equations by multiplying a factor $(1 - u_t)$ to the parameter a (rate of influx of T-cell). Here u_t may be thought of as the drug efficacy factor. For no T-cell suppression u_t can be set to zero and $u_t = 1$ means complete suppression of T-cells. Thus the variation of the drug efficacy factor u_t must be governed by the condition $0 < u_t \leq 1$. Under such circumstances the model equations could be recast as

$$\begin{aligned} \frac{dL}{dt} &= a(1 - u_t) - \delta LM - \mu L \\ \frac{dM}{dt} &= b - \beta LM - \mu' M \\ \frac{dK}{dt} &= \eta LM - \lambda K \end{aligned} \dots\dots\dots (4)$$

Equation (4) are solved numerically with varied forms of the drug efficacy parameter u_t along with other model parameters.

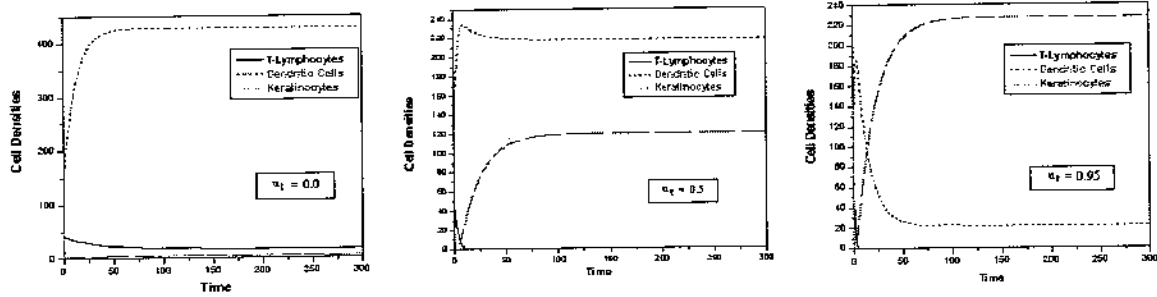


Figure 3: Progression of model variables with time for various constant values of drug efficacy parameter u_t , whose values are shown in the panels. Various model parameters are set to their numerical values as in Table-1 and initial values of variables are set as $L(0) = 50, M(0) = 50, K(0) = 2$

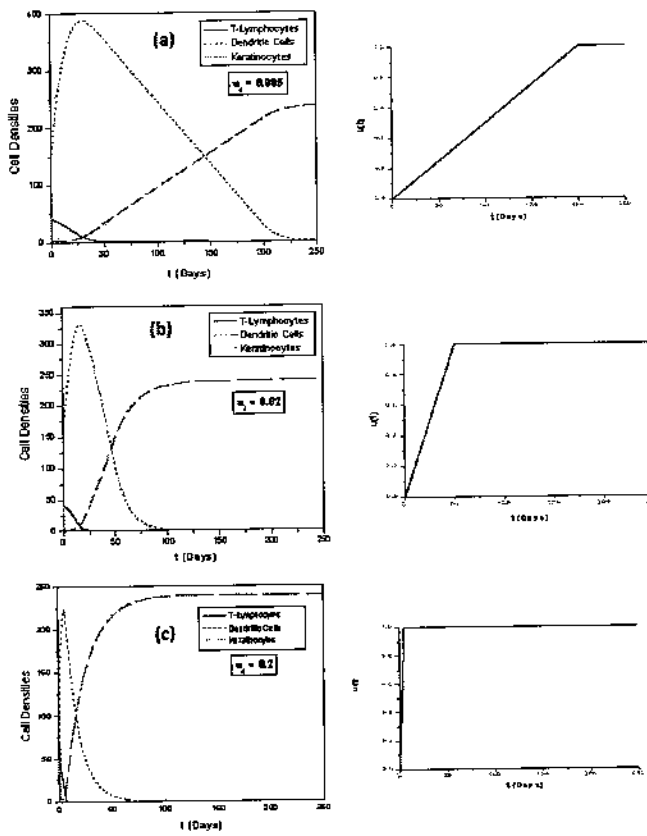


Figure 4: Time series solutions of model variables for linearly rising drug efficiency parameter u_t . Rate of rise of u_t is varied in plots in upper to lower panels. Variations of u_t are depicted besides the respective panels. Various model parameters are as in Table 1.

In Figure-3 we give plots of the progression of different model variables as a function of time. In the left Panel we set, $u_t = 0$ that is no suppression of the (local accumulation of) helper T-lymphocytes. The middle Panel shows a plot where u_t is set to a time-independent constant 0.5 and in the right panel $u_t = 0.95$. In all these panels variable masses of $L, M,$ and K are asymptotically stable and constant suppression of T-cells inflict a suppression in the asymptotic stable keratinocyte mass. Also, the dendritic mass gets enhanced as the constant value of u_t approaches its upper bound 1 and asymptotic keratinocyte

mass degrades to a very small numerical value satisfying a roll-back from psoriatic pathogenesis.

Time series solutions of the model variables are plotted in Figure-4 with the drug efficacy parameter u_t being made to rise from 0 to its upper bound 1 linearly with time as $u_t = u_d t$, where u_d represents the constant gradient (increment) in u_t . In Panel (a) the curves refer to $u_d = 0.005$, whereas in Panel (b) $u_d = 0.002$ and in Panel (c) $u_d = 0.2$. The corresponding variations of u_t are given beside the Panels. Here again we find that the keratinocyte mass falls to very low values, and an increasing u_d makes the fall progressively faster. This again signifies that the gravity of pathogenesis is practically subsided. Note that the increasing u_d makes the dendritic cells density to rise to higher and higher value before falling to a low level.

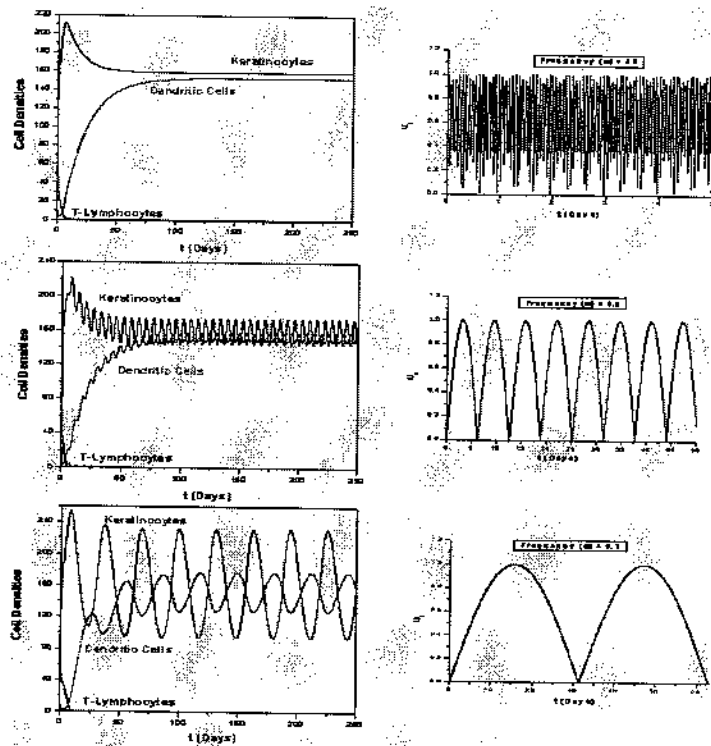


Figure 5: Solutions for different cell-biological masses for oscillatory variation of drug efficacy parameter u_t within the limit $0 < u_t \leq 1$. Model parameters are as in Table 1.

In Figure-5 we plot the L , M and K masses (model variables) as functions of time with an oscillatory variations of $u_t = |\sin \omega t|$, where ω is the angular frequency of oscillation (Time period of oscillations $\sim \frac{1}{\omega}$). In Panel (a) the curves correspond to $\omega = 50$, and in Panel (b) $\omega = 0.5$, in Panel (c) $\omega = 0.1$ (very long time-period). The oscillatory variations of u_t are given

beside the respective Panels. In all these plots we find the asymptotic solutions of different variables representing relevant cell biological masses are stable. However a decrease in the frequency of oscillation of u_t makes the stable solution for DCs and keratinocytes oscillatory. The amplitude of oscillation in these masses gets sharply enhanced with the decrease in angular frequency ω (or the increase in the time period of oscillation). In this case of oscillatory u_t a strict roll-back from pathogenesis is almost unobservable. However for a long time period of oscillation in u_t (very small ω) short-lived role-back from pathogenesis are apparently observed, which refers to the lowest value of keratinocyte density in a definite cycle of oscillation of k . Note that the oscillatory

suppression of T-lymphocytes induces an oscillation in the Dendritic cells' density making the time series solution of M asymptotically stable but oscillatory.

5. Discussion and Conclusions

Analysis of the basic model has been carried out for fixed point solutions of model variables L^* , M^* , K^* . Fixed point solutions, as obtained analytically through expression (3) do agree with those obtained from the rigorous numerical solutions of model equations. Analysis of the basic model establishes that there exist single-valued stable asymptotic solutions for the model which show consistent behavioural changes as the model parameters. Note that the default values of model parameters are fixed both by analytics and numerical calculations.

Psoriasis is understood to be the autoimmune disease where T-lymphocytes play a significant role. The same is emphasized clearly while analyzing the basic model. To have a detailed understanding about the role of the T-lymphocytes in the model dynamics numerical solutions of the model are considered by introducing the T-cell suppression. We find that a constant T-cell suppression over the complete time scale considered, makes the keratinocyte proliferation lowered. When the magnitude of (constant) T-cell suppression is large ($u_t = 0.95$, i.e. close to the upper bound $u_t = 1$) the asymptotic keratinocyte density is significantly lowered implying absence of psoriatic-pathogenesis (Figure-3). Further we considered a linearly rising T-cell suppression and we again find that (Figure-4) as soon as the magnitude of suppression nears the upper bound ($u_t = 1$), the psoriatic pathogenesis becomes nonexistent (signified by degraded keratinocyte proliferation). Here we observe that, faster the u_t approaches the value $u_t = 1$ sooner the roll-back from psoriatic pathogenesis occurs. We have considered a sinusoidal variation of u_t bounded within $0 \leq u_t \leq 1$. We observe that in such cases the roll-back from psoriatic pathogenesis is not complete. As we increase the time period of oscillation from a very small to a high value the rate of abnormal keratinocyte growth (responsible for psoriatic pathogenesis) manifests oscillation (of increasing time period) with its numerical value ranging from moderate to high. This is apparent in Figure-5.

The idea of suppression of T-cell, as discussed above, is coined from the domain of clinical therapy for disease like psoriasis. Clinically, it is possible to inflict such T-lymphocyte (helper T-cells) suppression may be possible through specific therapies. Different types of variations of u_t (suppression parameter) as considered herewith would relate to analogous local inhibitor therapies. A constant u_t would mean application of therapeutics of constant magnitude, a linearly varying u_t would mean a progressive increase in the magnitude of applicable therapeutics with time and ultimately reaching to the saturation level corresponding to $u_t = 1$. The oscillatory u_t could be improvised clinically by applying therapeutic interruptions magnitude changing between 0 and saturation level with time.

In conclusion, we have considered a basic density model for psoriasis, studied its asymptotic stable solutions to establish the sustainability of the model and explored possible ways of therapies that could be applied within the model. Our results are consistent with the clinical and cell-biological findings and could be put to further experimental test.

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Use of Arsenic Safe Alternative Water Options in Rural West – A Field Level Experience

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Abstract

Consumption of arsenic contaminated groundwater is causing severe health hazards and economic welfare loss particularly in rural West Bengal. To reduce these damages a number of alternative technological options have been developed to supply arsenic safe water to affected people. Preliminary observations made in Murshidabad district to assess the performance and acceptability of the alternative mitigation options. Field observations revealed that much thrust has been put on developing technologies for providing arsenic safe water as 'hardware' and on promoting their distribution and installation, but lesser attention have been put on the 'software' part i.e awareness generation and community participation. Cost-effectiveness, economic valuation never figured in the agenda.

Key words: Arsenic, Health Implications, Mitigation Options, Murshidabad District, Community Response.

1. Introduction

Discovery in the 1980s of arsenic in the groundwater of West Bengal, the main source of drinking water, has added a new dimension to the already existing water security problems in the state. At present in 79 -111 blocks of twelve districts in West Bengal where arsenic concentration in drinking water is greater than $50\mu\text{g}$ per litre [1, 2]. Around 24%-26% of the total tubewells' water samples have arsenic concentration above level of $50\mu\text{g}$ per litre. People at risk is around more than 5 million with 10134 people (including children) actually affected [1]. Consumption of arsenic rich water beyond permissible limit has very serious health implication and welfare loss [3]. Hyper pigmentation and keratosis, weakness, anemia, burning sensation on eyes, swelling of legs, liver fibrosis, chronic lung disease, gangrene of toes, neuropathy and skin cancer are some of the manifestation of arsenic consumption [4 - 6]. This leads to the high demand for arsenic safe drinking water.

To minimize the damage the best strategy is the provision of safe drinking water in the affected areas to protect human health from arsenic poisoning effect [7]. To mitigate the arsenic problem, a number of alternative technological options are available. Some of these options are based on surface water and some are based on treating the arsenic-contaminated groundwater. There is a continuous increase in expenditure for supplying arsenic safe drinking water to the rural sector.

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Since 1994-95, different measures have so far been taken to provide arsenic free water in the arsenic affected areas of West Bengal (Table 1). A sum of rupees 876.75 crores has already been spent by March, 2007 [8]. Therefore it is very much important to assess the effectiveness of the programmes under taken by the government to supply arsenic free water in the rural areas in West Bengal.

Table 1: Different Arsenic Safe Water Supply Schemes in West Bengal.

Measures/Schemes	Number
Short-term Measures	
• New hand pump fitted	8037
• Dug/Ring wells	166
Medium-term Measures	
• ATU with existing hand pump Fitted tube wells	2396
• ARP for existing groundwater based piped water Supply Scheme (PWSS)	12
• New big diameter deeper aquifer tube wells for existing PWSS	8
• New groundwater PWSS	233
• Nadia Murshidabad groundwater based PWSS	01
Long term	
• Surface Water based Pipe Water Supply Scheme	03

Source: Public Health Engineering Department (PHED), 2007

2. The Problem

Governments and other agencies are mainly attentive to identification, mitigation and supply of safe drinking water as 'hardware'. But how much has the emphasis on the hardware helped resolve the problem? What are the local community's responses on these arsenic safe water supply technological measures?

3. Methodology

To better understand the status of alternative mitigation measure the article concentrates on a single district- Murshidabad of West Bengal. Out of 8 highly arsenic affected districts in West Bengal, Murshidabad district has the highest recorded level of arsenic

concentration $5000\mu\text{g/L}$ as reported by Public Health Engineering Department [8] and $3000\mu\text{g/L}$ as reported by School of Environmental Studies [1]. The data for this study has been collected from in-depth key informant interviews, observations and focus group discussions during 2008 in two blocks in Murshidabad district viz. Jalangi and Raninagar-II. These two blocks are chosen because of the highest arsenic concentration reported so far [1]. With our study objectives in mind total 200 families were visited (taking 100 from each block) and each family member has been interviewed separately in the study area using pretested questionnaire. Household selection was done through random sampling. We visited all chosen habitations and identified the shallow tube wells for which concentration levels are reported. Then listed the households in the command area of each water source and randomly selected the number of households that they would interview. Different alternative technological options already made available in the arsenic affected areas were evaluated from the users' perspective in the local communities. In the area where the study was carried out, arsenic safe water was supplied by hand pumps attached Arsenic Treatment Units (ATUs), dug wells, domestic filter, Arsenic Removal Plants (ARPs) under swajaldhara scheme and pipe water supply scheme. The impact of each of these technological options which were adopted by different factors for supplying arsenic safe water in the chosen villages were assessed during the study.

4. Status of Alternative Arsenic Safe Water Technologies: Field Experiences

4.1 Hand-pump attached ATU

The ATUs have been installed in arsenic affected villages on a large scale basis by different agencies, which include PHED and the NGOs. Many of the spots with ATUs were visited during the study. A common condition that was observed in the case of the PHED-installed ATUs was reported to be lack of maintenance. This made them incapable of usage soon after installation. The communities had not been involved in the operation or maintenance of these plants. The local people were not involved in any of these cases.

The ATUs throw up several technical challenges that lead to questions of sustainability, especially in situations where communities are involved. On one hand, the efficiency of the unit in arsenic removal depends on the life of the medium used in the plant. This must be monitored on a regular basis to ensure the effectiveness of the plant. On the other hand, there is a requirement for regular backwashing, especially in the district where water had very high content. However, this will need the engagement of a regular operator who has to be present in the site of the installation. When government agencies had installed these ATUs, the cost of maintenance was one of the issues that it had overlooked. Therefore, during the study, none of the government installed ATUs were found under working condition.

Later on Bengal Engineering (B.E) College (Shibpur) developed a 'demand driven' approach where interested user families came together in a formalized user committee that agreed to undertake costs as well as responsibilities for the operation and maintenance of the ATU. The process in which this works is, these groups contribute a

monthly subscription towards the installed plant's maintenance and upkeep. Sometimes they also provide voluntary labour assistance when required for this purpose.

However, even after community participation was put into action, certain problems persisted. The ATUs were installed targeting the at-risk families in the community. But it was found that those families were prevented from using water from the ATUs. These reasons ranged from socio-cultural to economic. There were some other families which were not allowed to share water from the same ATU because of their religions. In addition to all these people disagreed upon sharing the costs of operation and maintenance of these plants due to the lack of trustworthiness of the committees formed. Consequently, these ATUs were not 'community-based', but was managed, operated and maintained by 3 - 4 families in the villages.

The common perception is millions of rupees are invested. But the benefits from ATUs are almost zero after eight months (on an average) as technology becomes dysfunctional. This has eroded confidence of the population towards new technology.

4.2 Tubewell

Villagers were mostly preferred (more than 80%) the use of either their privately owned tubewells or nearby government tubewells. When villagers were informed about the arsenic problem in tubewell water, some villagers started use of water (mainly for the drinking purpose) from the newly installed deep tubewells provided by Zilla Parishad/ PHED. Here we have informed two things-(a) when tubewells were in defunct condition, they were not repaired immediately, it takes a long time. In some cases local government (i.e Gram Panchayats) takes an initiative to remove that defunct deep tubewell and using the pipes of the removed tubewell install 2-3 (or more) new shallow tubewells. (b) in some areas some villagers were consuming the water from the same government tubewell (for any mechanical trouble, they were arranged by their own), but did not have any test result of the source water.

In the study areas covering 20 villages, safe tubewells were marked green and unsafe red. But presently people are not able to distinguish between safe and unsafe tubewells as painted colours either vanished or become fade. In some cases it was observed that the poor people were consumed water from the unsafe red coloured tubewell because of no alternative arrangements.

4.3 Dugwells

After knowing the fact that dugwell can be used as an alternative source of arsenic safe drinking water, some dugwells were installed in the arsenic affected pockets by the GOWB through Zilla Parishad. But for many reasons people avoid suing water from dug wells - some people said that they are used to drinking water from tube wells, some others have said that they find the water from dug wells foul in smell. While surveying, ten such dug wells were found in the study area, defunct. These dug wells now serve as objects of recreation for children or storage space of hay stacks where goats and sheep graze.

Table 2: Household's Knowledge about ATUs and Dugwells

% of household having the knowledge of alternative safe water options in the locality	94
% of household Reported installation of ATU in their locality	77
% of household Reported ATUs are in defunct condition in their locality	100
Average life span of the ATUs (after installation)	8 months
% of household Reported installation of dugwells in their locality	25.53
% of household Reported dugwells are in defunct condition in their locality	100
Average life span of the dugwells (after installation)	1.3 months

Source: Field Survey

4.4 Domestic Filter

Qualitative analysis of data indicates that managing domestic filters is perceived as quite a difficult task by women who have to handle the filters. The weight and size were the factors which women complained of, though filters of many shapes and sizes are available. They also complained of the efficiency of the filters especially if the family is large. The technical problems were reported by men in which they said that they didn't know anything about the life of the filter and the right time to change it. Logistic problems that the users encountered included lack of knowledge regarding regeneration or replacement of the medium and extra costs to be incurred for this purpose. In several Focused Group Discussions (FGDs) users also raised questions about safe disposal of the arsenic sludge. Statistical records show that the number of domestic filters which were sold up to March (2008) was 17615 out of which only 4158 (23.60%) were regenerated i.e change the media [9].

BPL families were provided with domestic filters free of cost. Sanitary marts had given these families domestic filters through the gram panchayats. To enquire the current status of these domestic filters, we had paid a visit to Chakchaitanya village of Jalangi Block where 26 BPL families resided. Conducting an FGD brought out such facts as these households had to only pay Rs. 25 for these filters. This money had to be paid to the village panchayat as transportation cost. However, after a few weeks these domestic filters were no longer used as filters. Some families had started using the filter as storage of food grains. One household was found where the filter was kept aside and the lower part of the filter was used as a storage space for drinking water. It is evident from these observations that the filters have nearly no significance for them and that these people tremendously lack awareness regarding this matter.

UNICEF's initiative to supply arsenic safe water by supplying arsenic removal domestic filters at free of cost through NGOs to the children of rural primary school has completely failed. Three filters were supplied to schools. 5310 domestic filters were provided to a total of 1770 schools in eight districts. But only in Nadia district (Out of eight districts),

50 schools (0.9%) regenerated the media upto March, 2008 [9]. From the field survey in Murshidabad, we observed not a single school is using the domestic filters. Teachers are saying 'who will clean/operate these filters?' Teachers are more concerned about the mid-day meal programme of the school. In some schools, domestic filters are used as a container of rice, vegetables etc. of Mid-Day Meal programme.

4.5 Arsenic Removal Plants (ARPs) under Swajaldhara Scheme

Like B.E College plant, ARPs are 'community-based' approach. But for the reasons range from shortcomings of the managing committees, unwillingness of the villagers to pay for arsenic safe water, to village politics was managed, operated and maintained by 3 – 4 families in the villages. We have also observed that due to the non availability of electric supply in the village, the plants could not be operated for example at Kadamtala and Rajatpur of Katlamari-I Gram Panchayat (GP), there were plants installed which could not be operated due to non availability of electricity. In some places projects are functioning well where there are champions (like educated young man, women and local Bazaar Committee members) who take the risk of initiating and leading the programmes. Five such ARPs were visited among which two (40%) are not functioning due to the lack of electricity, one (20%) maintained by only 3 – 4 families in the villages, remaining two (40%) are well maintained by bazaar committee.

4.6 Pipe Water Supply Scheme (PWSS)

In villages where pipe treated arsenic safe ground water was supplied, it was observed that these water taps were publicly widely used by women as points for washing clothes, utensils and vegetables and by men and children for bathing. These pipelines arise originate from distant treatment plants or pumping stations. It was found in some cases that these pipelines had been damaged leading to impure water supply. Some other damaged pipes kept overflowing as the supply was on. Both men and women, users of this water supply, complained of irregular supply and/ or discontinuity in supply for several days together. Additionally what made them vulnerable is that there was no local agency where they could approach to lodge a complaint or even move to get the supply restored.

We have observed that the stand posts in the pipelines that were laid were not distributed in equal distance as a result of which water supply to areas is affected greatly. As for example in some densely populated areas there were no stand posts placed whereas in some other areas there were many stand posts at short distances. Consequently many people can't fetch water because of the long distances they have to cover.

Villagers reported that (i) at night someone breaks the pipe and use the water for irrigation (ii) time to time some one breaks the water supply pipe line to fill their tank when enough water is not for Pisciculture (iii) Pipe lines were also broken when enough water is not available for wash the jute (iv) during the construction of road, bridge etc, pipe lines were broken. Because of these reasons villagers are not getting the benefits of PWSS.

A certain population (4%) was found not to drink water from these pipelines. On being asked why, they stated that the water tasted unusual which made them deem it unfit for drinking. The men identified the smell as that of chlorine's and they know chlorine as some agent for cleaning water.

There is a certain population (6%) which does not drink water from these pipelines because the number of people collecting water from the few stand posts is so huge that they have to wait in long lines to get their share of water for daily use. There are petty fights and quarrels in the line also. People who consume water from the pipelines have felt that their symptoms of arsenic poisoning have not increased. While surveying we observed that the unfortunate sight of the terrible wastage of water from the stand posts since the stand posts had no tap mouths to stop the flow of water from them. The concerned authorities are absolutely indifferent towards this wastage.

There exists a strong disparity between the coverage and accessibility. Field observations could also show that while some areas are over served by various technologies some areas are deprived of the benefits of installations.

5. Present Source of Drinking/Cooking Water

To know whether people have now shifted to alternative safe water options after knowing that their residing area has water infected with arsenic, respondents were asked about the source of drinking/cooking water they used to procure water before they knew about the presence of arsenic in the water they use for their daily living and what is their present source of drinking/cooking water. Most of the households (98%) reported that before knowing that the water they use has high arsenic content, they used water from tube wells. Only a few (2.5%) reported about the use of water from dug wells but presently they were using water from tube wells installed by governmental or private sources. Again there are some households (5.5%) who previously used tube well water but presently are using their own or their neighbours' dug well water. 1.5% households shifted from tube well water to water supplied by the swajaldhara, 32% shifted from tube well to PWSS. 59% households are still using contaminated tube well water. 53% households do not know whether their present source is arsenic safe or not. Still 13.5% households are continuing to use arsenic contaminated tube well water mainly due to the non-availability of safe options in the near place.

Information was sought on respondents' perceptions on the quality of water being consumed. Respondents were asked whether or not they are satisfied with the present source of water. 44% households in the sample area were satisfied with their present source and among them 69% did not report any problems with the quality of water they used. However, 57% were not satisfied with their present source of water. Among them 74% complained about bad quality water, 8.9% reported about arsenic contamination, 13.3% said that they were compelled to drink from the present source contaminated (Table 3).

Table 3: Reasons for Satisfaction/Dissatisfaction over Present Water Sources

Satisfied		Not satisfied	
Reasons	No. of households	Reasons	No. of households
Good quality water	60(68.97)	Bad quality water	84(74.3)
Arsenic Safe	20(22.99)	Arsenic unsafe	10(8.85)
Others say quality of the water is good	4(4.60)	Compelled to drink/there is no alternative options	15(13.27)
More than one reason	3(3.45)	More than one reason	4(4.54)
Total	87(43.5)		113(56.5)

Source: Author's estimation (Figure in the parenthesis represents percentage)

6. Preference Ranking of Alternative Mitigation Techniques.

Information on consumer preferences is important to design user friendly schemes to be implemented in future. Only a small percentage of households in the arsenic affected areas use or are currently using any of the five selected technologies, or are familiar with only one or two technologies, respondents have been briefed about the merits and demerits of the five technologies. Issues such as modern technologies, low cost, provision of good quality water, others (like O & M cost) are briefed, and were asked to rank these five technologies. The findings show that about 58.5% of the respondents rank PWSS first, 32% of the respondents place second rank to swajaldhara, 33.5% put third rank to dug wells, 36.5% respondents put fourth rank to tube wells and 75% respondents put fifth place to ATUs (Table 4).

Table 4: Preference for Alternative Mitigation Measures

Technologies	No. of households reported their preference				
	I	II	III	IV	V
ATU	2	2	14	32	150
Dugwell	25	34	67	62	12
Deep TW	14	39	43	73	31
Swajaldhara	42	64	58	29	7
PWSS	117	61	18	4	0

Source: Author's estimation

7. Willingness to Pay (WTP)

Respondents were asked whether they were willing to get arsenic safe water for their family and willing to pay for the O & M of those mitigation measures. 100% respondents were put their positive response for getting arsenic safe drinking for their family. For value elicitation, respondents were asked to choose between Rs.10 per month to Rs.100 per month. The survey results show that as contribution charge increases, number of contributors decreases and vice versa. About 8.5% of the respondents were unwilling to pay mainly because they could not afford the cost.

Ability to pay is examined by looking at the household income and expenditure figures. The average WTP towards O & M of the mitigation measures is Rs.26. In relation to the income and expenditure, low income (BPL) group households are willing to pay (WTP) substantially greater proportion of their incomes. BPL households are willing to pay 1.1 percent against 0.99 percent in case of middle income group, 0.27 percent in case of higher income group. In terms of expenditures also BPL households are willing to pay more than their counterparts (table 5).

Table 5: Average Willingness to Pay for Water and Household Income and Expenditure

Income group	No. of HH willing to pay	WTP			Monthly Income (Rs/Month /HH)	Monthly Expenditure (Rs/Month /HH)	Mean WTP as % to income	Mean WTP as % to expenditure
		Mean Value	Median Value	Mode value				
I	86	19	10	10	1738	1608	1.1	1.2
II	88	32	20	10	3239	2792	0.99	1.1
III	9	28	20	20	10250	6130	0.27	0.46

Source: Author's estimation

7.1 Estimated Revenue and Cost Recovery Potential

WTP bids can be used to determine the economic sustainability of providing arsenic free water. These bids are useful for estimating the number of household water supply connections and revenue generated from the provision of supplying arsenic free water.

Table 6 and figure 1 shows number of connections and revenue generated per 100 households corresponding to the various tariff rates. Table 6 indicates revenue generated is highest, Rs 720, when tariff rate is Rs. 40 and percentage of connections is 18. Up to Rs. 40 revenue increases, however beyond Rs. 40 (i.e. at Rs 50) revenue falls drastically to Rs. 325 and increases thereafter. It is to be noted that revenue generated is higher up to Rs. 40. So tariff rate between Rs. 10 and Rs. 40 is better than that between Rs. 50 and Rs. 100 because dual objective of revenue maximization and maximizing the number of connections can be achieved in the former tariff range. However exact rate depends upon the objective preference of the policy makers.

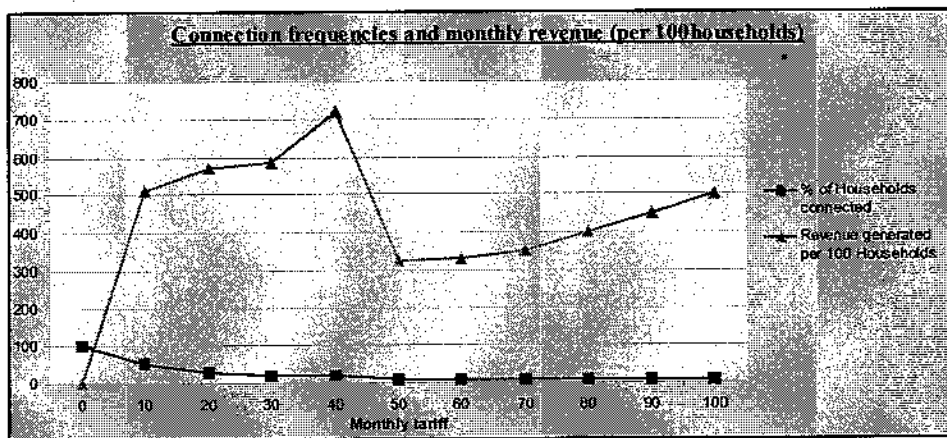


Table 6: Distribution of WTP, Household Connection Frequency and Revenues

Monthly tariff	Number of Households	% of households	Cumulative % of Households	% of Households connected	Revenue generated per 100 Households	Value of Elasticity
0	17	8.5	8.5	100	0	Inelastic ($e < 1$)
10	81	40.5	49	51	510	
20	45	22.5	71.5	28.5	570	
30	18	9	80.5	19.5	585	
40	3	1.5	82	18	720	Elastic ($e > 1$)
50	23	11.5	93.5	6.5	325	Inelastic ($e < 1$)
60	2	1	94.5	5.5	330	
70	1	0.5	95	5	350	
80	0	0	95	5	400	
90	0	0	95	5	450	
100	10	5	100	5	500	

Source: Author's estimation

Figure 1: Household Connection Frequency and Monthly Revenue (per 100 Households)



8. Conclusion

There has been quite systematic scientific approach to provide arsenic safe water in West Bengal. Government and non government actors are working towards mitigation of the

problem. The approach so far taken to tackle the situation in West Bengal is dominated by technological solution. Easy money flow and easy technology flow were there but the management aspect, economic aspects were silent and hence failure. Cost-effectiveness, economic valuation never figured in the agenda. As a result, financial sustainability, technical sustainability, participatory approaches never come in forward. Demand management had never been the goal. Supply management which dominated was also not planned with long term vision or within cost-effectiveness. Any future action needs strong economic incentive design as supplementary to technical intervention.

Acknowledgement

Author acknowledges with thanks the financial support from the University Grants Commission (Eastern Regional Office, Kolkata) under the Minor Research Project Scheme part of which has helped in conducting the pilot survey.

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Geopolitical Conflict in Kashmir-Himalayan Region: A Review on Geographical Perspective

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Abstract

The Great Himalaya is not only a 'Natural Wall' between Indian sub-continent and Middle Asia but is a divergent line of different cultures. Kashmir is a Buffer region between the two rival countries e.g. India and Pakistan. There is a long political conflict in the Kashmir-Himalayan region. But undoubtedly it is not only a political dispute among the two rising powers (India and Pakistan) of South-East Asia to control over the so-called controversial area. According to Structuralism, the root of conflict lies in economic, anthropogenic and cultural structure of the respective area. Though most of the regions are geographically far-reaching due to unfavorable topography and climate but they are full of natural resources. Besides many biotic (i.e. forest resource and habitat of rare species of flora and fauna) and abiotic resources (like water resource), the regions have Tourism resource also. On the contrary, the transitional region has its own history and unique cultural entity. Now a clash between 'People' and 'State' (whatever at present they are controlled by a particular country) is rising which is not always mere political issue. The problem of land, resource and culture of the concerned region is interesting issue in modern Geopolitics as well as Social Geography.

Keywords: Geopolitics, Buffer Region, natural resources, Structuralism, Cultural entity, Political Geography, Social Geography

Introduction:

Famous Swedish political geographer R. Kjellen (1864-1922 A.D) defined 'Geopolitics' as 'the science of the state as a realm in space'. Sometimes it is defined as 'Spatial Organization of Politics'. Today the study of 'Geopolitics' [1] in Political Geography is very essential in respect of critical world politics.

Geographical location of Himalaya is significant in the geopolitics of South-East Asia. Because it is not only a 'Natural Wall' between Indian sub-continent and Middle Asia but is a divergent line of different cultures. Apparently, the problem of the Kashmir-Himalayan region is political but from geographical view-point there are so many economic, cultural and ethnological factors behind this. The present paper deals with the contemporary geopolitical issues [2] of the very regions in the light of Political as well as Social Geography.

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Main Objectives :

The main objectives of the present paper are as follows :—

- a) To identify the present scenario of geopolitical conflict in Kashmir-Himalayan region.
- b) To describe the historical and ethnic background of the so-called controversial areas.
- c) Keeping aside mere political outlook, an analysis of the problems of the respective regions in geographical perspective.
- d) To reveal the rising conflict between 'People' and 'State' (whatever at present they are controlled by a particular country).
- e) Apart from Positivist Approach, to search the root of problems in Structuralist point of view.
- f) A concluding remarks to overcome the problems.

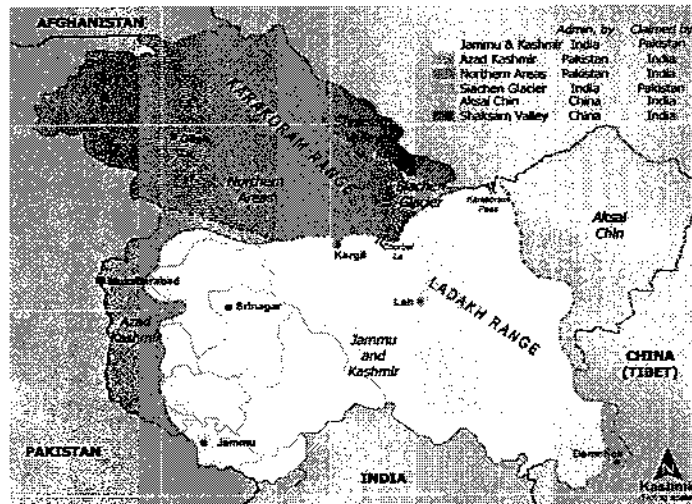
Data Base and Methodology :

Data and information have been collected by Field Survey and from reliable books, scholarly articles, daily newspaper and different websites. The maps in this paper have been taken from Atlas, Google Map and various books.

Mainly it is a descriptive and analytical paper but some cartographic techniques have been applied to justify the facts. Some maps have also been used to support the theoretical description.

About the study area :

Kashmir(32°17'N to 37°3' N latitude and 72°25'E to 80°20' E longitude) is the northwestern region of the Indian subcontinent. Until the mid-19th century, the term Kashmir geographically denoted only the valley between the Great Himalayas and the Pir Panjal mountain range. The state of Jammu and Kashmir is spread over an area of 222236 square kilometers. Jammu and Kashmir is bordered in north by China, east by autonomous region of Tibet, south by Indian states of Himachal Pradesh and Punjab, and west by Pakistani city of Rawalpindi and Frontier Province and on North Western side by Afghanistan. India Controlled Kashmir 106,567 sq.kms (48%), Pakistan Controlled Kashmir sq.kms 78,114 (35%) and China Controlled Kashmir 37,555 sq.kms (17%). Contemporarily, Kashmir denotes a larger area that includes the Indian administered state of Jammu and Kashmir (Jammu, Kashmir, and Ladakh), the Pakistani administered Gilgit-Baltistan and Azad Kashmir, and the Chinese-administered regions of Aksai Chin [2].



Control over Kashmir by India, Pakistan and China

Long-lived Kashmir problem :

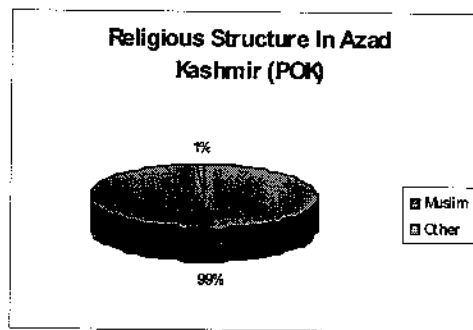
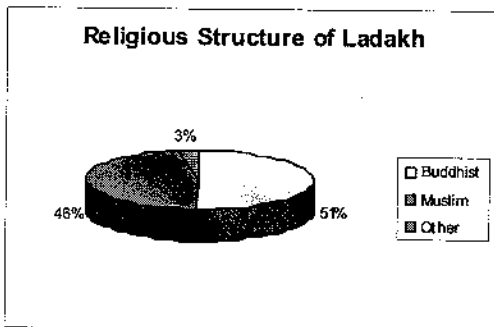
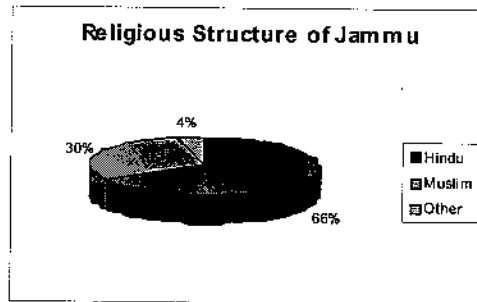
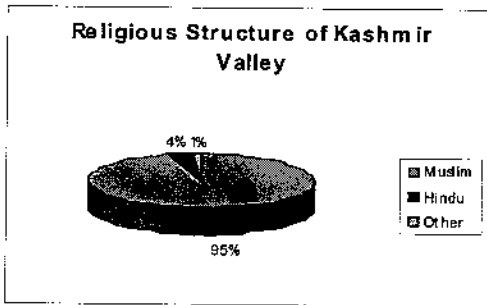
Behind the geopolitics of a long warp and woof in connection with Jammu-Kashmir lies a complicated history, geography and ethnology. Accordingly, it is necessary to analyze the long-lived Kashmir conflict geographically instead of traditional political analysis.

Partition of India: Fault at root

Where does exist cultural boundary ?

It is an undeniable fact that on the basis of Two-Nation Theory India was partitioned. The creation of a new state on the basis of religion is not a new fact in world history [3]. On appearance, it seems to be undesirable but a rational ground behind this lies. This can be illustrated with reference to a lot of historical events. Bangladesh (created on the basis of language) is a vivid example before our eyes. Applying Two Nation Theory Pakistan was created with the Muslim dominated regions of India (West and East Pakistan) and the rest of India remained as independent India [8]. The problem didn't end here. A problem arose with the existing independent states in sub-continent. They were granted full freedom either joining to Pakistan or to India. But in case of Hyderabad, Junagarh and Kashmir a critical problem arose. The rulers of the last two States were Muslim, though most of the citizen were Hindus. The Muslim rulers of the States endeavored to join with Pakistan. But it was not possible for two reasons — a) most of the people were Hindu and b) geographically they were not adjacent to Pakistan. On this ground the then Home Minister Sardar Ballav Bhai Patel included the two States in India. He didn't care for the earnest desire of the

Muslim rulers because he didn't allow to create another two small 'Pakistani Pocket' within independent India. Hari Singh, the then king of Kashmir and Sk. Abdullah, the most popular leader were in favor of annexing Kashmir to India on some conditions. But the majority of the population of Kashmir were Muslims (almost 80%). As the major criteria of partition was on the basis of religion and geographically Kashmir is adjoining to West Pakistan, so it was reasonable for Kashmir to be included in Pakistan [4]. Therefore, the present boundary between India and Pakistan has become purely 'Political'. Where does lie the 'Cultural' boundary — is a vital question between Pakistan and India.



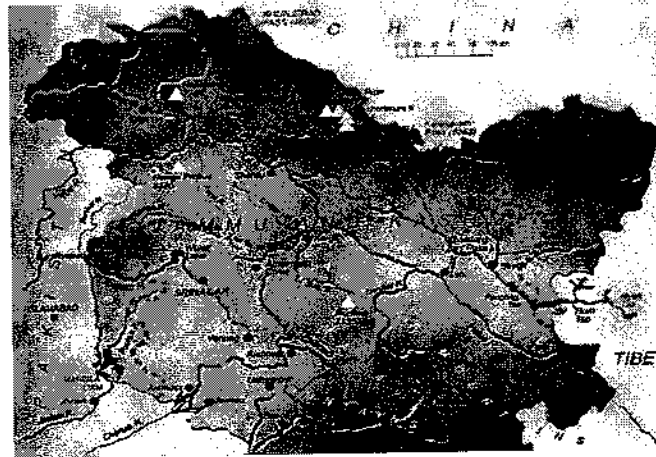
Cause of conflict: Strategic significance of Kashmir

Physiographic significance : Politics over a River

The northwestern part of the Indian subcontinent is dominated by the Indus River and its system of upper tributaries. Originating 17,000 feet (518 m) above sea level in a spring near Lake Manasarovar at Mt. Kailash the Indus then traverses a distance of 1800 miles (2900 km) through Tibet, India, Pakistan occupied Kashmir (POK), and Pakistan before draining into the Arabian Sea south of Karachi. On its way, it is further enriched by the waters of several tributaries, the most important and discussed in this article are Beas, Sutlej, Ravi, Chenab and Jhelum rivers.

The India Independence Act enacted in 1947 by British Parliament and the subsequent British withdrawal from India left the subcontinent partitioned between two independent

states marred by demarcation problems along their international boundaries, the peculiar circumstances leading to the division, and the accession of a number of princely states especially that of Jammu & Kashmir straddling India and Pakistan as well as the complex riverine systems of Indus, Ganges, and Brahmaputra. Of these three rivers, the Indus presented a complicated set of issues stemming from thousands of kilometres of man-made irrigation canals and head works that regulated the flow of its waters. While all the rivers, except Indus and Sutlej, originated within Kashmir, the headworks located mostly in the Eastern Punjab were awarded to India. The treaty [6] was signed in Karachi on September 19, 1960 by Indian Prime Minister Jawaharlal Nehru and President of Pakistan Mohammad Ayub Khan. The treaty was a result of Pakistani fear that since the source rivers of the Indus basin were in India, it could potentially create droughts and famines in Pakistan. Aside from the Punjab Boundary Commission suggestion that the canal-headworks system be treated as a joint venture, a proposition rejected by both countries, it had not deliberated water sharing of Indus River Basin due to a hasty partition that was completed in a mere 73 days. Water sharing issues of Indus River System would later take over a decade to resolve. Further complicating this issue, Pakistan covertly and later overtly sought to grab Jammu & Kashmir for various reasons including the desire to control the waters of these rivers that succeeded in instilling only distrust among Indian minds.



Common rivers of Kashmir and Pakistan

Siachen Glacier:

Glaciers are ablating rapidly the world over. Nowhere are the rates of retreat and down wasting greater than in the Hindu Kush-Himalaya (HKH) region. It is estimated that over the next century, 40,000 square kilometers of present glacier area in the HKH region will become ice free. Most of this area is in major valleys and the lowest glaciated mountain passes. The existence and characteristics of glaciers have security impacts, and rapidly changing HKH glaciers have broad strategic implications.

Although glaciers are generally incompatible with human development and habitation, many of the HKH region's glaciers and their mountains have become sanctuaries and transit routes for militants. Siachen Glacier in Kashmir has for 17 years been "the world's highest battlefield", [9] with tens of thousands of troops deployed on both sides of the India/Pakistan line of control. In 1999, that conflict threatened to trigger all-out warfare, and perhaps nuclear warfare. Siachen is the world's largest glacier beyond the polar regions, and it also claims the dubious distinction as the world's highest-altitude battlefield. Since 1984, India and Pakistan have engaged in a military dispute in this remote corner of Kashmir. The Siachen conflict can ultimately be traced to post-colonial territorial ambiguities, with science tangled in the origins of the dispute through early scientific, surveying and sporting expeditions. The human, environmental, and economic costs of this conflict have been devastating for both nations, and there is rising interest in resolving the dispute by establishing a transboundary scientific peace park on Siachen.

Geopolitical significance of Kashmir

It is due to the geographical location Kashmir has become an asset to Pakistan, India and China. Its strategic importance is undeniable to the world. It is a just like a watching tower from which India in South, China in the East, Asia-Minor in the North and the whole Middle-East in West can be observed [5].

Why does Pakistan long for Kashmir ?

It has been said before long that at the outset Pakistan longed for Kashmir for geographical proximity and religion. That's why Pakistan attacked India just after independence but at present demand for Kashmir on the part of Pakistan is superficial and not acceptable [5,7]. The hard reality lies in the geographical significance of Kashmir—

- 1) If Pakistan succeeds in taking away Kashmir it will be easy for her to observe rival India more closely. Particularly North Indian plane including Punjab will easily be observable.
- 2) Afterwards, it will be possible for Pakistan to set up a close relation with China. Besides this, strategically Pakistan and china jointly will have the chance of pressurizing India.

What is loss for India if Kashmir is slipped away ?

India in spite of all impediments intends to exercise control over Kashmir for the following reasons—

- 1) India is always trying her best to beat back Pakistan in West and China in East.
- 2) Including Indus many rivers of this region flowing towards West and South fall on Sindh (Pakistan), Punjab and North-Indian Plane. Controlling the source of these rivers is strategically significant [6]. Apart from this some important passes are also there in the Kashmir region.

If Kashmir becomes out of her hand, all these physical features will come under the control of Pakistan and China. As a result India will be heavily affected geographically, economically and its security will also be at stake.

- 3) With the rest of India even world, Kashmir is a very attractive tourist spot. In this sense, it is a great source of income for India (Tourism) also.
- 4) On all sides of India communalism and separatism have raised their voice. If Kashmir becomes separated from India the so-called militants and communalists will be encouraged and inspired to fulfill their demands. In near future this will be a challenging factor on the part of the militants.

Solution of the problem:

Discussions have been taken place among the conflicting countries to solve the continuous problems in Kashmir region. But all the same, no satisfactory formula has been found out. Because the burning problems have been analyzed only from political point of view. Considerable facts conducive to the geographical solution of the problems are as follows —

1) Social well Being :

This is due to the conflict of the powerful states the developmental activities of Kashmir have almost been stopped. Even there is lack of basic amenities like transport, electricity, drinking water and treatment etc. It is the developmental works which can satisfy the common people. In the Article 370 of the Indian Constitution some special privileges have been granted to the people of Kashmir but unfortunately some political parties of India (like Bhartiya Janata Party/BJP) are opposing to this.

2) Human Rights :

The powerful States are always violating the human rights of the adjoining regions for establishing their sovereignty. At present incidents of this kind are happening incessantly in entire Kashmir region which has created a concern to International level. Right to equality and freedom has no practical value today. Even the people of the said regions have lost their courage to express themselves freely. Sometimes in order to keep back the burning problems of the regions 'Terrorist', 'Separatist' have been stamped on the local people. So it is necessary to find out the root cause of their allegations and anguish and think over them sympathetically.

3) Acknowledgement of different cultures :

Racial identity is hereditary in nature. Sometimes it is active and

sometimes it is hidden. Every man on earth desires to be survived with respect and identity. So now is the time of recognizing 'Diversity in unity' along with the 'Unity in diversity'.

Concluding statement:

In the light of the aforesaid discussion one can think that Jinnah's (father of nation of Pakistan) 'Two -Nation Theory' or Woodrow Wilson's 'One Nation One State' political concept have been recognized indirectly to solve the present situation. But it is not right at all. The problems have been analyzed entirely from geographical, economic and ethnological point of view. The implication of knowledge of Political Geography may be effective in solving the long-lived problems in the aforesaid region.

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Inefficient Primary Education and inaction of the Stakeholders, an enquiry

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Abstract

Inefficiency in the delivery of Primary Education, particularly in developing countries like India, has been a long-standing problem. Various studies time and again has focused on this aspect of economic development, more so since primary education provides higher social return compared to private return and hence inefficiency in this sector may seriously hinder the path of development. The problem is more serious for countries like India, where an overwhelming majority of the population has to depend on the govt. run primary education system. Different surveys, reports and studies have time and again shown that we have been very slow in developing an efficient primary education system, particularly the govt. run ones. This paper tries to look at the problem from the stakeholders' point of view and analyze their role in the system. With the help of some simple game theoretic tools we build up a model where we try to understand the role of the stakeholders in maintaining the status quo of inefficiency.

Keywords: *Primary Education, Economic Development, Social Return and Private Return, Game Theoretic Tool.*

1. Introduction:

The purpose of this paper is to theoretically explore the reasons behind persistence of inefficiency in delivery of primary education in countries like India. With the help of some simple game theoretic tools we try to build up a model to understand the role of the stakeholders in maintaining the status quo of inefficiency.

The paper begins with a brief introduction of the economics of primary education that puts up a strong case for public investment in primary education. Section 2 focuses on the parental behavior in presence of gross inefficiency. The paper ends with a conclusion and some policy prescriptions.

1.1 Background of Study:

Human capital theory holds that investment in human resources results in improved productivity, and that both the costs of the investments and the benefits of improved productivity can be used to calculate an economic rate of return. Human capital investments generally take the form of education or training and may include health care as well. An educated labour force is better at creating, implementing and adopting new technologies, thereby contributing to total factor productivity growth. Returns to primary

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education may be classified into two parts, private and social. Private rates of return accrue to families from human capital investments. Social rates of return from investment in primary education consider positive externalities such as diffusion of knowledge, democratic values and practices, and more freedoms for individuals in society so that the transaction cost is reduced. The existence of social returns provides a rationale for public investment in primary education. Given high social rates of return to primary education, there is an economic rationale for addressing the problem of low access to credit to poor families for financing primary education. An inability to borrow to cover educational costs creates a financial barrier to educational attainment, which governments usually choose to overcome by reducing or eliminating fees for primary education.

Let us now focus our attention towards the case of India. At the time of independence, the gross enrolment rate at the 6-14 age groups was just 42 per cent. The rate is now as high as 96.3% (Census 2001). But on the flip side, the reality is that 42 per cent of the children enrolled still drop out before completing primary education and another 19 per cent drop out at VI-VIII level [1]. There are still one-lakh habitations in the country having no schooling facility within a kilometer. Coupled with it there are various systemic issues like inadequate school infrastructure, high teacher absenteeism, large number of vacancies in teaching posts and poor quality of teaching. In most of the cases, including the latest one by Pratiche Trust, absence of the Teachers in the school has been pointed out as a major reason behind this inefficiency. The picture will be no different if we look at the scenario prevailing in West Bengal. West Bengal still stands a dismal 33rd position in Educational Development Index among 35 Indian states and union territories [2]. A survey by the Pratiche Trust[3], undertaken for a few representative districts of West Bengal reported that the rate of literacy among the scheduled caste communities remains as low as 42.21 per cent in West Bengal. Almost 15 per cent of the populations in the age group 6-11 were out of school in 1997-98. There is on average 2.98 teachers per school, a suffocating student-teacher ratio of 54:1 far higher than the declared ratio (40:1) of the government.

Why do a high percentage of students drop out at the primary level? There might be various reasons including the entry of the children in the labour force. But as the report of the Pratiche Trust indicates, one important reason might be that the government run primary schools fail to attract the students to continue their studies. In spite of enhanced emphasis on public investment for elementary education, the society might fail to achieve success in universalizing primary education unless the delivery system overcomes the constraints.

In India two types of delivery system exists for Primary Education. The first one is the privately run system of pre-primary and primary schools which caters mainly the middle class, upper middle class and high income classes. The other is the vast network of Govt. run schools, which provides service to the lower middle class and downtrodden. If we look at West Bengal in general and Kolkata in particular we observe that broadly speaking, there are mainly four types of schools in Kolkata which are: privately run

schools, state government run schools, state government aided/ sponsored schools, union government run schools and union government aided/ sponsored schools [4]. In so far as primary education is concerned, apart from the privately run schools and union government run / aided / sponsored schools, there are the government schools that are run by the West Bengal Board of Primary Education (WBBPE) which is the organ of the state government concerned with the dissipation and management of elementary education in the state and the Kolkata Municipal Corporation Primary (KMCP) schools, which are run by the Kolkata Municipal Corporation (KMC). In case of primary education, there is no difference in the government run, aided and sponsored schools since the management and funding of all these schools is the responsibility of the West Bengal Board of Primary Education [5].

In case of privately run schools, education is mainly considered a merit good and market rules do take care of efficiency/inefficiency in these sector. However for the large majority of population there is no other alternative but to depend on the state run delivery system and it is here that the problem of inefficiency is not automatically taken care of by the market forces. Since the market does not exist for the non-privately run primary schools, the efficiency of the system is basically determined by the efficiency of the delivery system. While it is true that various administrative measures are taken for improving the delivery system, it is often stated that such measures would fail to produce desirable results unless the stakeholders (parents of the children) play the expected role in enhancing the efficiency of the system. In my paper I want to look into this issue in particular. Understandably, the schools should function better if the relevant wing of the state could play a role in disciplining the staff (the school teachers in particular) even if the involvement of the parents remains marginal. This possibility shall have to be taken into consideration while discussing the issue of the efficiency/ inefficiency of the government run primary schools.

How should the situation improve? A collective movement on the recipient's part against the existing inefficient system if successful may create the proper ambience for improvement. But as our experience suggests nothing such attempt has occurred over the last few decades. My attempt in this paper will be to look at the theoretical possibilities as regards the effectiveness of these measures in enhancing the efficiency of the delivery system. The possibilities will be discussed in the framework of the theory of game.

1.2 Game Environment

Let us begin with a truism. The process of improvement of the delivery system must start from a point where there is gross inefficiency. And the system must have been defective for a considerable length of time. This lends some justification to the view that the state of their powerlessness is equilibrium for that length of time. We can view this equilibrium as the outcome of a game. The players of the game have different strategies and there exists a pay-off matrix. The Nash-equilibrium refers to the point where the combination of the strategies produces the best results for both the players. Now, who are the players? In the context of the state-run schools we consider a particular game environment. The model captures the scenario where the parents of the school going children who intend

to improve the quality of the primary education by taking recourse to collective action (demonstration, building up local pressure, denying the access of the teachers to the community life etc) against the teachers. The players in the game are the individual parents. In the model we would consider this game environment and find out the possible outcomes of this game.

2. Collective movement of the Recipients:

2.1 The Game:

Let us start with the story of a closed society with a defective primary education delivery system. Since the social order is defective, the impetus for system improvement must come from parents themselves. It is, therefore, a question of collective action by them. Let us now describe the game structure. This is a game that a representative parent, henceforth R, is playing against 'all other parents', henceforth O. R does not, however, consider him to be a representative. He is far from sure that he will be joined by others in his action of revolt in the event of him choosing that. This distrust is generated by the communication failure. The second point to note about this game structure is the totally mysterious nature of the other player O. This amorphous body of other parents cannot make any strategy choice in reality, yet its existence, as a player is real and potent in the mind of R. Whenever R contemplates an action, he has to consider the possible 'action' of this ubiquitous O. This makes his action a strategy, and the structure a game.

In this game, R can either cooperate with the mission of protesting against the system (in which case he is playing C), or defect from this mission (in which case he is playing D). He knows that O also has the same options of strategies. He, however, does not know the strategy O will actually choose. Instead, he assigns probabilities p and $q (=1-p)$ to O's choosing C and D respectively. He chooses C or D depending on which one gives him a higher expected pay-off. Since he is representative of the collective, his choice turns out to be the choice of everybody. If R chooses C, everyone else also chooses C by symmetry, and collective action materializes and change results. Similar logic implies that R's choosing D means that collective action will not be launched.

Let $U(s_i, s_j)$ for $i, j=1, 2$, denote the pay-off to R corresponding to the strategy combination (s_i, s_j) , where s_i is the i^{th} strategy of R and s_j is the j^{th} strategy of O.

The pay-offs are described as follows.

$$U(C, C) = p_s(b+c-v) + (1-p_s)(e+c-v-x); \quad U(C, D) = e+c-v-x-m;$$

$$U(D, C) = p_s(b+v-h) + (1-p_s)(e+v); \quad U(D, D) = e+v; \quad \text{where}$$

p_s : subjective probability that improvement will result from collective action;

b : pay-off (perceived benefit) from improvement per se;

x : perceived explicit penalty imposed by the delivery system on a crusader in the event of failure;

m : cost of alienation associated with a lonely revolt;



- c: commitment value accruing to R when he cooperates;
 h: cost to a lone defector in the event of success of improvement mission;
 v: pay-off from maintaining status quo; it is lost when R goes against them; the child may be rusticated from the school or ill-treated.
 e: pay-off from whatever benefit an average child is entitled to in the existing system.

By construction, all the above variables are nonnegative. It is assumed that improvement results whenever O chooses C.

The pay-off matrix is given by table1, which by incorporating the variable p (and q) gives a complete description of the game environment.

		O	
		C, p	D, q
R	C	$p_s(b+c-v) + (1-p_s)(e+c-v-x)$	$e+c-v-x-m$
	D	$p_s(b+v-h) + (1-p_s)(e+v)$	$e+v$

In this generalized set-up, condition of a cooperative outcome turns out to be

Expected pay-off from cooperation > Expected pay-off from defection

$$\begin{aligned} \Rightarrow & p\{p_s(b+c-v) + (1-p_s)(e+c-v-x)\} + q(e+c-v-x-m) > p\{p_s(b+v-h) + (1-p_s)(e+v)\} + q(e+v) \\ \Rightarrow & c + p.p_s.h - 2v - (1-p.p_s)x - (1-p).m > 0 \end{aligned} \quad (1)$$

Here, the LHS denotes the expected net gain from cooperation, say G.

Thus, failure of the delivery system does not automatically lead to parents' revolt. The latter crucially hinges on the fulfillment of inequality (1). Whenever this condition is not met, and in most cases it is not met, the equilibrium of the game perpetuates exploitation.

Evidently, c, h, p_s , and p (cluster-I variables) are positive influences on prospect of cooperation, while v, x, and m (cluster-II variables) are negative influences.

Assuming that the revolt will lead to success, in which case all are expected to co operate, we can assume that $p = p_s = 1$

The problem can thus be formulated as maximize L.H.S. equal to $G = c + h - 2v$.

Max. $G = c + h - 2v$, and $p = p_s = 1$.

p, p_s

Therefore, necessary condition of collective action is $c + h - 2v > 0$ (2)

2.2 Some other results:

Consider Equ(1), $c + p.p_s.h - 2v - (1-p.p_s).x - (1-p).m > 0$, This is the case where net expected benefit from cooperation is positive. This implies that in this situation all people are expected to join the movement and success of the mission may result. Given that $p, p_s=1$, then the condition becomes $c+h-2v > 0$ (2)

$$\Rightarrow c > 2v - h \quad (2a)$$

$$\text{or, } (c+h)/2 > v \quad (2b)$$

Equation (2a) implies commitment of R towards the mission must be sufficiently high compared to the benefit, which he receives by maintaining status quo. The variable h on the RHS has a negative sign implying the cost to a defector in the form of being alienated from the society. This also implies that higher is the value of h compared to v, higher is the expected pay-off and hence higher is the expected pay-off and hence higher is the chance of success. The cost of defection should be sufficiently high.

Equation (2b) implies that pay off from maintaining status-quo must be sufficiently less.

From condition (1) we get $c > 2v + (1-p.p_s) x + (1-p) m - p.p_s.h$. If there is little or no probability of success, then $p_s = 0$, i.e. probability of success is nil.

$$\Rightarrow c > 2v + x + (1-p) m \quad (2c)$$

Further if we assume that the person is sure to join the revolt, then $p=1$.

$$\text{i.e. (2c) becomes } c > 2v+x \quad (2d)$$

This means that in the situation where there is no chance of success, the individual is highly probable to join the revolt (expected net gain from co-operation is positive), only if there is a very high commitment of the individual towards the cause.

Suppose we now assume that R is not sure about others joining him in the action. Then

$$0 < p < 1, \text{ then, } c > 2v + x + gm, \quad 0 < g < 1 \quad g = 1-p, \quad (2e)$$

The variable m, enters the scenario only when $0 < p < 1$ i.e. the person is not sure of joining the movement.

Sup, we add a constant k to the RHS of (2e) to convert the inequality into equality.

$$c = 2v+x+gm+k. \quad (3)$$

$$\frac{dc}{dm} = g > 0 \quad (3a)$$

The higher the cost of alienation (associated with lonely revolt) for an individual, higher will be the commitment towards the mission.

Lastly if we consider; $p_s = 1, p = 0$.

In this case expected net gain from cooperation will be negative when $c-2v-x-m < 0$. The

explanation runs like this; the expected net gain from cooperation will be negative when the commitment of the people will be low compared to the combined negative effects against cooperation. In that case people will not join the revolt ($p=0$).

2.3 Observations:

- (a) Values of the variables involved in inequality (1) and (2) are exogenously fixed by the game environment. Since R is controlled by, and not a controller of, the game environment, fulfillment of condition (2) is a *fait accompli* to him. If the game environment is such that the condition is not fulfilled, it is not within his power to take the initiative to change the game environment so that the condition is fulfilled. The initiative to change the game environment must come from an exogenous source, which R does not represent. This can be termed as a catalytic agent of change.
- (b) Neither the term 'b' nor the term 'e' appears in condition (1). This implies that neither the perceived benefit from improvement nor the perception of current benefit determines the decision in favor or against joining a project of improvement. This occurs because R perceives that if others cooperate and the mission is accomplished, then no one can be excluded from its benefits, improvement being a public good. Similarly, if improvement does not materialize, everybody has to share the predicament of the relative inefficiency of the system. Moreover, he is also given to the perception that success or failure of others' cooperative move does not depend on his cooperation, because he is insignificant in the milieu. These two perceptions together render both 'b' and 'e' inconsequential so far the decision making of R is concerned.
- (c) The necessary condition (2) implies that $(c+h-2v)$ should be larger than zero. It should be recalled that this condition was arrived at by assuming $p = p_s = 1$, which implies that we are considering only the case when R thinks that others will cooperate and that their mission will definitely be successful. Under such condition, the net gain from cooperation turns out to be $(c+h-2v)$. Negative value for this term means that there is a positive net gain from defecting when others are cooperating. Therefore, (C,C) cannot be a Nash equilibrium. Thus, even if the pay-off from (C,C), i.e., $(b+c-v)$ in his case, is greater than the pay-off from (D,D), i.e., $(e+v)$, the latter becomes a Nash equilibrium, and the outcome (C,C) does not materialize. This is a classic case of prisoners' dilemma, and the collective irrationality stems from the existence of an incentive to defect, captured by a negative value of $(c+h-2v)$. However, if $(b+c-v) < (e+v)$, there is no perceived gain from improvement, and the question of 'dilemma' does not arise.
- (d) One extreme case where there is absolutely no dilemma can be characterized by: $(b+v-h) > (b+c-v)$, i.e., $(c+h-2v) < 0$; and $(e+v) > (e+c-v-x-m)$. This is a situation where strategy D dominates strategy C, irrespective of values of

'p' and 'p_s'. Here values of variables in the cluster (v,x,m) dominates the values in the cluster of variables (c,h). This is the expected result when $b \gg e$.

- (e) Since the necessary condition for collective action pertains to the most conducive case when both 'p' and 'p_s' are unity, fulfillment of this condition does not ensure cooperative outcome, as is expected of any necessary condition which is not sufficient.
- (f) The result obtained in (3a) may seem to be paradoxical considering the fact that a higher cost of alienation to a lone crusader instills more commitment in him towards the mission. The explanation runs as following; the fear of being alone in a movement may make people more committed towards the cause expecting that his own commitment will have a demonstrative effect on others.

Conclusion:

This paper started with a model on the delivery system of the primary education where improvement of the system would rest on the local initiative of the parents of school going children. Unfortunately as our study reveals, there is no built-in mechanism within the system to effectively capture the local initiative for improving the quality of education. No wonder the parents who are comparatively well off choose to defect from the state run schools to the privately run ones. Those who cannot exercise any other option have to accept the status quo since any isolated movement may lead to further sufferings for them.

Given the current structure and ambience of primary education delivery system there is thus little hope that status quo will not persist. In the absence of a strong movement on part of the stakeholders the system has no self-correcting mechanism to insert a greater efficiency. This is why an inefficient system could persist over such a long period of time. This is a classic case of 'prisoners' dilemma' where the collective irrationality stems from the incentive to defect. Absence of sufficient economic and legal entitlement makes effective intervention in the system impossible for a vast majority of population. Thus for the vast majority of population without sufficient entitlement there is no other option but to accept an inefficient education delivery system for their children. This has a direct bearing on the future generation as children who belong to this inefficient education delivery system may be edged out in future carrier struggle by their better counterparts. The system thus eclipses into a vicious circle with low enrolment, retention and a high failure rate. The only way in which the system may be improved upon is through strengthening of parental engagement, greater and effective political participation, particularly at the grassroots level. This calls for greater parental participation in the day to day administration of the schooling system and effective decentralization of the administrative system. No wonder states like Nagaland and Kerala who have been frontrunner in the field of decentralization of the primary education delivery system have made excellent progress in the field of elementary education while states like West Bengal have lagged far behind.

Reference:

1. Around 50 per cent dropout at primary level as recorded in NSSO 55th Round Survey and according to Census 2001, 43.5 per cent of children in 5 – 9 age groups are not continuing in school.
2. Educational Development Index is a recently developed index formulated by the Ministry of Education, Government of India to rank different states of India with respect to their educational achievement.
3. Sen, Amartya, 2002, 2009 'The Pratichi Report', Pratichi India Trust.
4. Ausmita Ghosh, An analysis of Primary Education in Kolkata, CCS working paper number 149.
5. A Hand Book on Primary Education (Relevant Act and Rules), West Bengal Board of Primary Education, Vol-1 & Vol-2.
6. The very structuring of the game environment ensures that values of variables in the cluster (b,c,h,p,p_g) move in tandem and in opposite direction to that of the variables in the cluster (e,v,x,m). For example, if the game environment reflects a lower degree of exploitation people can be expected to have a higher degree of awareness. This makes improvement dear (high b) and personal loss from lone defection costly (high h). This also makes people despise an inferior situation (low e), belittle the value of upholding traditional status (low v), and brave sanctions by the authorities (high c, low x and m). Again, this perceived evaluation of the objective situation by R instills a belief that there is a high chance that others will cooperate (high p) and the mission will succeed with united effort. This belief, this commitment, and these perceptions are all attributes of the mind, which drive people to action.

The Brahma Reform Endeavour and the Question of *Stri-swadhinata*

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Abstract

The social reform in nineteenth-century Bengal was a complex response to the presence of British colonial rule. Western education unleashed a plethora of newer ideas and visions from the West which found expression in the efforts of western educated middle-class whose reform endeavours put the ethos of indigenous culture and western ideas of liberty in the same bracket. This was best reflected in their efforts to address the 'women's question' which saw the options and choices provided to women of respectable families in defiance of existing social customs, yet recasting them in a new mould of Indian womanhood. The quest for *stri-swadhinata* or women's emancipation as envisaged by a group of Brahmo reformers in their own way during a period, which is often branded as the beginning of Indian modernity and the process of women's liberation in India. The Brahmos, already outcaste in a tradition-bound society for their negation of the Hindu rituals of idol worship, had their own idea of progress and tried to break the shackles for the ladies of their own homes. The debate around the question of *stri-swadhinata* had been thus begun. In a seemingly paradoxical way these reformers were asking for female emancipation at a time when people of the country was in subjugation under foreign rule. The tide of nationalism and patriotism that engulfed the nation in the next century swept away the question for the emancipation of women.

Key Words: *andarmahal*, Brahma Samaj, women's emancipation, social reform, nationalism, nineteenth century

"Women are not allowed to see anything. A pole has been built over the river Ganga in Kolkata, people praised it so much but we only heard about it. We could not bridge the gap between sight and sound even for a single day" [1].

"If the progress of women is taken for consideration, it is seen in the present times that the basis of the national awakening is the awakening of women...Unlike before, the change that is seen in the world of women nowadays is that woman is no longer confined to the dark corner of her home with her small interests – she is now out to fulfil the greater tasks she has in this world" [2].

Introduction

The cited passages from the writings of two Bengali women, writing more than half a century apart, reflect the change in attitude of the contemporary Bengali Hindu middle class women toward construction of space. With the British rule firmly established in India by the middle of the nineteenth century, there were ripples felt all over the country

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under its huge impact. The domain of the Indian women did not remain unaffected in its core. The question of the present article seeks to look into the issue of *stri-swadhinata* raised by Brahma reformers, and whether their effort really touched a chord among middle class female whose lives came to be transformed as a result of these changes.

In the second half of nineteenth century *andarmahal* (inner quarters) was the designated space for the women of respectable households. Women were subject to a normative social model where their place was at home and meeting outsiders were not encouraged. Their near total absence from public life became an issue when a section of the western-educated middle class male reformers championed *stri-swadhinata*. It came to be associated with their entry into the public space, receiving education in schools and participation in public life. Under the influence of Unitarian Christianity some members of the Brahma Samaj had already exhibited their protests against the Hindu forms of idol worship. The discourses of western enlightenment, its sense of liberalism encouraged these men to question the value system that kept women confined in *andarmahal*. They realised that social practices were intertwined with religious practices and *deshachar*. Hence, attacking one of these issues made them imperative to address the other.

The Push Factor For Reform

The *andarmahal* of the middle class Bengali Hindu homes caught the attention of India's British masters. While the white women were quite visible, especially after 1850s, their native counterparts remained *purdahnashin* (one who was confined within veil or inner quarters). Accounts of white women, who were often permitted inside the *andarmahal*, were the only testimony to the colonial masters about the living conditions of the native females. It spoke of a life of ease, often fun-filled with the women giving company to each other, sharing gossips, recipes, cosmetics etc. They had a world of their own, where spoken words, gossips, verses and doggerels were replete with sexual overtones. Women from lower castes and poorer sections had easy access to the women's quarters and often provided them with the only link to the outside world. The popular form of entertainment meant for *Bhadralok* women, led to a homogenous form of popular culture inside the *andarmahal* which increasingly came to be associated with 'vulgar' and 'licentious' tastes [3]. The writings of a few white women were critical of the proclivities, tastes and attire of the native women which seemed to be quite obscene and vulgar to their tastes attuned with a sense of Victorian morality. Some missionary accounts, as well as one section of the Anglo-Indian press, reiterated the views of such English women who spoke negatively of *purdah*. Here women were 'doomed to inactivity' with 'lack of education or access to it and tyranny of the mother-in-law'. "Moreover, architecturally too the *purdah* was seen to signify both 'native' fears for the women's chastity as well as fears of the women's own potentially disorderly desires" [4]. Therefore, to save these poor women from the oppressions of domestic drudgery became 'a white-man's burden', a notion gradually percolated among the English educated enlightened native male.

There are several instances of women being encouraged to step outside the seclusion of *andarmahal* and gradually adapting themselves to the institutionalized education system

outside their homes. The impetus provided to them came largely from their enlightened fathers, brothers and husbands, who were often part of the Brahma social reform movement. Western educated middle-class male became reformers in their efforts to take their wives to public gatherings, parties, and to their workplaces if it was away from their ancestral home. Those men who went abroad for studies or for writing examinations were often inspired by their encounters with British women and their social milieu that encouraged free mixing and public participation. For example, the first Indian civilian Satyendranath Tagore supported the cause of women's emancipation and wrote to his wife regularly inspiring her to improve herself. Defying familial opposition, he took his wife, Jnanadanandini Devi, to a party in the Governor General's house. She later emerged as an icon of the modern Indian emancipated women. Another example was the progressive Brahma leader Manomohun Ghosh who wanted a liberated educated wife. But attempts to bring the Brahma women outside inner quarters were not taken well by the members of the Samaj. Progressive Brahma leader Sivanath Sastri wrote that during the visit of Miss Mary Carpenter [5], a special service was held in the house of Keshub Sen. "The advanced section of the progressive party mustered strong on this occasion with their wives, setting an example of female emancipation by introducing the latter to their male friends...this inoffensive and very natural action on their part exposed them to severe criticism even in Brahma circles, including Mr. Sen, who viewed this step with grave displeasure and held forth many warnings in the columns of *Indian Mirror*" [6]. Similar attempts of social reform was noticeable in the Brahma Samaj chapter of Barisal especially from 1860-1865. Debendranath Tagore, the head of the Tagore family and an illustrious leader of the Brahma movement, had already permitted a Brahma male, Ayodhyanath Pakrashi, a non-relative of the Tagores, inside the *andarmahal* for imparting education to the girl children [7]. Within the fold of the Brahma Samaj increasing awareness was felt for public participation of female members. In 1865 the female members of Barishal Brahma Samaj started openly participating in the prayers of the Samaj. In 1878, the special prayer of Maghotsav (usually held on 25 January every year) came to be conducted as an *acharya* by a lady named Manorama Majumder [8]. She was an exceptional woman who was appointed by Barisal Brahma Samaj as lady missionary in 1881, to work among the females [9].

The Tortuous Road to Women's Emancipation

What was the impact of such changes in the mindset of the womenfolk? Did they feel emancipated? Contemporary biographies of male reformers and accounts and letters of a few women enable us to peep into their mental world. The women often embraced these principles and happily followed the guidance of their husbands; but a sense of ambiguity was also not uncommon among them. Born and bred in the world of *bratakathas* and feminine customs, they sometimes found it difficult to cope up with such emancipated western ideals. Wives of Brahma leaders often remained traditional; many actually followed the age-old customs and practices since they suffered from a sense of insecurity, especially because their husbands had embraced the fold of Brahmaism. Brahma leader Bijoykrishna Goswami writes, "At that time the wives of the Brahmos were

usually referred to as Brahvikas, otherwise except for a few most of the Brahvikas were in favour of idolatry – they attended the Brahvikas Samaj on the request of their respective husbands” [10].

In fact, the lives of Brahmo wives bore evidences of their dilemma. They were in a fix whether to blindly follow the husband's lead or to remain true to traditional beliefs. Most of them married early and learned household works in their in-laws' house. Sometimes, their reformer husbands provided them with elementary education, but they had to keep it secret since in the rural areas female education was not particularly welcome. They looked after their aged in-laws, and all family members, toiled at home performing all the household chores from morning till night, usually bore a number of children, reared them up and worshipped the household God. But some of these women, who never received any kind of support from their otherwise enlightened husbands showed enormous courage and strength of mind. Bamasundari Devi, the wife of the Brahmo reformer Chandicharan Sen, was one such woman who performed her father-in-laws last rites in the absence of her Brahmo husband (who was not accepted in his native village for becoming an infidel) and was the pillar of strength against attempts by the relatives to marry off her eldest daughter at the age of six and half years only. Later she was taken by her husband first to Barisal and then to his workplace at Pirozpur and in the end to Kolkata. Throughout she kept her faith intact in Hindu forms of worship and caste system. At the same time, she was in favour of education and late marriage of her daughters, one of whom grew up to be a famous poet and another a doctor [11]. and that at a time when even many emancipated Brahmo women were giving marriage to their daughters quite early. However, she could not be the ideal, educated Brahmo wife as per her husband's aspirations and nurtured a feeling of inferiority throughout her life. But she tried in her own way by participating in Brahmo prayers and by her efforts to read and learn along with her daughters [12].

The eastern Bengal chapters of the Brahmo Samaj, especially at Dacca, Mymensing and Barisal were very active in giving shelter to widowed women and arranging for their marriage. Here young and energetic Brahmo men with zest for radical path-breaking reforms took initiative in rehabilitating the widows. They attempted to coordinate between the ideas they preached and action they took. In fact, in most cases they rescued young widows, and unmarried girls facing the persecution of a *kulin* marriage, gave them in marriage – including love marriages and inter-caste marriages – in these centres. Because of their actions they had to face the wrath of the orthodox society. Social persecution and losing rights over ancestral properties were some of the common social discriminations they had to face in their lives. Here *brahmikas* were found to assist their husbands in providing refuge to the rescued women and giving them away in marriage. Sarada, the widowed sister of the Brahmo reformer, Srinath Chanda of Mymensing, gradually transformed herself and read religious tracts instead of the worship of Shiva. She was a child widow, who used to fast on the *ekadashi* days, and could sing devotional songs as well. Thus she lived the pure life of a devout Hindu widow. But taught to read by her brother and exposed to Brahmo prayers and ideals she was drawn towards a different life. She on her own accord arrived at Mymensing, where she stayed with the

family of the Brahmo leader Bhubanchandra Sen and participated openly in the Samaj prayer along with Hemangini Devi, the wife of Bhubanchandra. This incident sparked off a lot of excitement and the Mymensing chapter decided to abolish the purdah for women in the prayer hall from then onwards [13]. In the lives of widowed women like Sarada and Sukhadasundari, a new awareness was noticeable and they took their own decisions regarding their future course of life. The Samaj and the progressive ideas of its reformers provided them with a new choice erstwhile unknown to them. Both these women came under shelter of progressive Brahmo reformers and expressed their desire to remarry against all odds. A lot of commotion took place in Mymensing and Barisal when Sukhada's parents sought the help of police and district magistrate against the Brahmo leaders. But Sukhada showed enough determination by not relenting on the face of parental opposition. She was later remarried to another Brahmo reformer [14]. Bamasundari, the sister of a Brahmo preacher, Baikunthanath Ghosh, was a child widow who received elementary education under her brother's tutelage. Knowing about her hard life her brother suggested an escape to Brahmo Samaj to which she readily accepted. She received help from her brother and other Brahmo compatriots. She took her own decision, but still felt quite apprehensive while leaving her parents' home at the dead of night. She needed the assurance of her liberator that she did the right thing by leaving home [15]. In fact, her life was an example of the way women's mindset was changing. Later she was residing in Brahmo ashram with other Brahmo families and participated in prayers openly that led to a spiritual uplift and strengthening of her mind. She later married the Brahmo leader Srinath Chanda. Their marriage, which took place in 1876, was the first instance of widow remarriage as well as Brahmo marriage in Mymensing [16].

Several instances show that women had to fight against the odds to come out of the clutches of age-old traditions. In August 1871, in Dacca, a *kulin* girl named Bidhumukhi was rescued from a mismatched marriage. She herself had expressed desire to break free of the shackles. She fled home with the help of two young Brahmo men, and saved herself from getting married to a man, who had already married a dozen times earlier [17]. In another instance Bhubanmohini wrote to her father Brajasundar of her willingness to marry progressive Brahmo leader Rajanikanta Ghosh. Brajasundar was initially against such proposal since the marriage would have been consecrated and registered under the Brahmo Marriage Act of 1872 (Act No. 3 of 1872). Bhubanmohini was, however, bent on marrying Ghosh, and finally her father yielded to her. The marriage was registered in August 1876 [18]. In these cases exercise of choice by the protagonists is noteworthy. Women increasingly felt the urge to take their own decisions which was a new thing. Instead of marrying the chosen groom early in life as selected by the parents or relatives, these women decided their own course of life. Education with its proposition of comfortable livelihood as well as consensual marriage ideals seemed more attractive to them. The craving for female education among the women was discernible from the incidence of Nityakali Devi of Sohagdal village, Bikrampur who fled her native village in 1872, with her son and two daughters in her quest for education and late marriage of her daughters. She received shelter in Dacca and later in Calcutta where her daughters grew up to be educated and consequently married off to Brahmo illustrious leaders [19].

On another occasion in March, 1873 Lakshminiani, the daughter of a prostitute, studying in Dacca, was about to be forcibly drawn by her mother to prostitution. Some Brahmos led by Nabakanta Chattopadhyay rescued her and handed her over to Sivanath Sastri. The hapless girl was brought within the ambit of education and later married off. But being the daughter of a prostitute her rehabilitation was not easy [20].

Women Emancipators: Masters of Their Fate, Captains of Their Soul

Let us now turn to the lives of Saraswati Sen, Haimavati Sen and Brahmamoyi Dev whose urge to participate in constructive work outside the domain of domesticity heralded a new era. Saraswati Devi became a widow in 1858 at the age of eleven only. She received education under the scheme of *antahpur stri-siksha* (programme of female education within inner quarters) in her native village. Later she became a student of Bethune school and in 1880 she was appointed as a teacher in the same school where she taught for nine years. She used to take her students to Brahmo Samaj mandir for Sunda prayers and supported the cause of rehabilitation of the widows as envisaged by the progressive Brahmos. She became self-sufficient and led her life by her own means. She donated all her properties for the service of Brahmo Samaj in her native village of Khantura in north 24 Parganas. She advised the weak-minded widowed women to remarry and lead a conjugal life if their sensory urge was too strong, or to sacrifice their lives for the service of the Brahmo Samaj if they were strong-willed and could keep their faith on God relentlessly. She herself chose to live the second type of life [21]. Another lady whose life had some similarities with that of Saraswati Devi, was Haimavati Sen who became a doctor, a remarkable feat in those days, by sheer determination and perseverance. Her aspirations of higher education leading to employment brought her to Brahmo Samaj. This child widow grew up to be a determined young lady who never once was deviated from her path amidst many kinds of temptations and obstacles. She had first hand encounters with many stalwarts of the Samaj which were not always pleasant but many like Nabakanta Chattopadhyay, or Sivanath Sastri, Chandicharan Sen, D Sundari Mohun Das were really sympathetic to the cause of women and generally helped them and advised them well in times of crisis. In a crucial juncture of her life when she was penniless and without any place to go, she received help from the ashram of Brahmo Samaj. But she was also critical about some reformers and some practices of the Samaj. She alleged that the Brahmo leaders were not really concerned about women who came from outside the fold of the Samaj or were unrelated to Samaj members [22]. Brahmamoyee was the wife of Durgamohun Das, the illustrious Brahmo reformer of Barisal. She was in favour of women's education and employment. She did not support child marriage and provided refuge to widows against social opposition [23]. Another illustrious lady was Kadambini Ganguly who was one of the first graduates among the female. She chose to become a doctor and went abroad to achieve higher degrees in medicine. She married Dwarakanath Ganguly, the well known Brahmo reformer who defied the norms of society to educate his wife and to provide her with any kind of support [24]. Her "case was hardly typical even among the more emancipated Brahmo and Christian women in contemporary Bengali society. Her ability to rise above circumstances and to realize her potential as a human being made her a prize attraction

to Sadharan Brahmos dedicated ideologically to the liberation of Bengal's women"[25]. But the orthodox press lashed out at Mrs. Ganguly as a despised symbol of modern Indian womanhood and accused her of being a whore. Dwarkanath Gangopadhyay took legal action not only to defend his wife, but to support the principle of liberating women.

In spite of these examples such women were few in number who pursued any career outside home. Those women, who were shaping their lives on the new mould, chose to live a life as chalked by their husbands and brothers who were actually casting the women in a new mould, an amalgamation of traditional values with certain newer ethos. Baring a very few, most of the reformers actually wanted a wife who should be an ideal companion and assist her husband. Such women were many who were taking the vows of their husbands and helping them to achieve their goals. Prasannamoyee, wife of Sivanath Sastri, Ambika Devi, wife of Shibchandra Dev, Brahmamoyee, wife of Durgamohun Das, Aghorekamini, wife of Prakashchandra, Lilavati Mitra, daughter of Rajnarain Basu and wife of Brahma reformer Krishnakanta Mitra, Nistarini Devi, wife of Rajnarayan Basu are such examples who received education by the initiative of their husbands or fathers and later inculcated a habit of reading books, attending prayers regularly or providing refuge to widows and helpless women when their husbands indulged in such activities. But they never neglected their household duties, managed domestic affairs like keeping a tight reign over the escalating costs of living or rearing up a number of children amidst many obstacles- and all with ease. Shibchandra Dev, the regional Brahma leader from Konnagar, Hooghly, who was a loyal servant of the colonial administrative machinery, and a stalwart leader of the Sadharan Brahma Samaj after the split, expressed his gratitude to his wife Ambika Devi for her commitment towards domestic life and for being the perfect *sahadharmini*. She brought her children well and imparted among her daughters the valuable education befitting a virtuous woman [26].

Many Shades of Reform: Ambiguities, Crisis of Identity and Reactions

The male reformers varied in their potentialities as radical reformers. The women generally followed the male lead and remained loyal to them on the face of stiff opposition from near and dear ones. In most cases they could go as much as their patrons allowed or wished them to go. Sometimes when the reformers by whose support she defied the norms failed to provide her with assistance, their condition became worse. Keshub Chandra Sen, the great Brahma leader and champion of women's rights was ostracised by his family members in early life for becoming a radical Brahma. He emotionally forced his child wife Jaganmohini to follow him when he left home, but did not stand by her side when she was humiliated and received very cold behaviour from her in-laws later in life. Keshub Chandra advised her to remain calm and contented with whatever came on her way and thus did not pay heed to her anguish to a large extent [27].

This kind of ambiguity was even found in the activities of many a *progressive* reformer. They seemed to oscillate between traditional belief which was ingrained in their upbringing and enlightened ideals as imbibed from the west. Enlightened, liberal ideas encouraged them to break certain social practices, but they remained apprehensive of

their outcome. Age-old customs and *deshachar* could not be ignored altogether as also they felt a responsibility to prove wrong the allegations charged against them by the orthodox press. Therefore, internal contradictions remained an innate feature of their reform endeavour. Moreover, their negation of Hindu ritual of idol worship led them to a sense of crisis in identity that also left its mark on their activities. Keshub Chandra Sen, for example, changed his standpoint a number of times. Why he did so has not been adequately explained. Rajnarayan Basu, another stalwart of the Adi Brahma Samaj noted, "We should conduct our reformatory movements in a national way so as to suit the tastes and ideas of the nation without compromising our Brahma principles" [28]. Rajnarayan Basu was in favour of limited reforms for women that would not compromise the age-old customs of chastity, modesty prescribed for Hindu females for centuries. He believed that attempts to change should be slow and should not be done on impulse [29]. Keshub Chandra also nurtured similar feelings. He felt that changes led by the progressive party were merely symbolic and external and that a fundamental change of the mindset was necessary in the first place. He was against such tendencies of rushing through the reforms to improve the condition of the women. Freedom to him was the liberation of the soul and liberation of the mind, which could be achieved by the women of our country following the path of righteousness and true religion [30]. Keshub Chandra used to give formal advices to the ladies attending the Brahmika Samaj established in 1865. In his first advice he told the women, "The first advice to you is that do not blindly imitate the religion followed by the male, no improvement of your womanhood is possible by taking part in every activity of the male...the female ideal cannot be father, preceptor, husband or brother or anybody who is revered in this world for the male countenance and female character is totally different" [31]. Women were told to look upon God as their mother, not as father and perform the duties assigned to them which were devotion and service. He criticised the women for their attempts to build their own households with the husband alone and neglecting such lofty ideals like universal love, service, attainment of virtue, humility etc. Whereas he accepted the women being confined to their homes like caged birds made themselves narrow, the solution lay not in liberty, but in practising virtue and spiritualism and by sensing the presence of almighty in their very existence [32]. When he spoke against worldly aspirations and promoted spiritualism, he was actually negating the western notions of enjoyment and outer beauty. "The brahmikas, the children of god, you should practise innocence. Do not follow the instance of the world for the world will teach you dishonesty, will tell you to be civilized in your external manners and dress...In the name of civilization, what was practised was dishonesty" [33].

Keshub Chandra Sen, the follower of western ideals of liberty in early life turned to Hindu asceticism and spiritualism in later life which was reflected in the ideals of Nababidhan Samaj or New Dispensation. But he could not rise above pettiness in dealing with those members of Brahma Samaj who were promoting female liberty. In *Sundar Mirror*, the mouthpiece of Keshub Chandra's party, strange sayings in the name of God came to be published. "Ye hypocrites, your character is as questionable as your faith. Ye are sold to wine and woman...Some of you who have not yet gone to the extreme o

bestiality are beginning to be sensual and voluptuous, and seeking woman's company with lustful hearts...Even where there is no actual immorality, I see great danger. *Where men are carnally panting for woman's company, and woman are carnally panting for liberty, there I see the seeds of great danger*" [34].

Brahmo reformers like Bijoykrishna Goswami were also deviating from the path of social reform as undertaken by the radical members. He felt anguished over the factionalism of the Samaj members. He felt that radical reform ideals done in the name of *civilization* was borrowed from the west. Liberal ideas indoctrinated their mind with ideas of emancipation which only meant free mixing of the genders. But this is not true emancipation, for the women of lowly class used to mix quite freely with the other sex, or travel from one place to another on their own since a long time, but they could not control their impulses. They followed the customs of the land knowing fully that these did not contain an iota of truth. Hence, "...freedom lay in the heart, not elsewhere. If mind could be improved by truth of knowledge, then only true freedom could be achieved...Development of knowledge would lead to a burgeoning sense of duty leading to growth of conscience that would help the women to do all activities on their own. Without the improvement of the sense of knowledge, the mind was bogged down by low ideals leading to impulsiveness" [35]. Bijoykrishna was quite flabbergasted by the rift among Brahmos on this issue. He reiterated his standpoint that one need not be favourable to women's emancipation on western model to prove that he was for freedom of the opposite sex. Freedom to him meant a different sort of freedom, not emulated by any outer influences.

Public reactions to the *stri-swadhinata* issue could be discernible from the newspapers and periodicals published in contemporary Bengal where various issues came to be contested, shaped and reshaped. These newspapers and periodicals delved into the question of female emancipation or *stri swadhinata* where letters from readers or published articles expressed their concern for women's escapade to the arena of public and how it would endanger the sanctity of the household. The writings expressed an inherent fear of the possibility of women becoming impulsive (*swechhachari*), lazy, prone to relaxation and neglect household duties and generally misuse their newfound independence. Newspaper reports, comments and social farces caricatured about women's education, independence, and employment which would make them akin to the female foreigners, used to a life of ease and comfort. Feminine nature being soft, dependent and indecisive; they could become easy prey to a large number of vices that included formation of illicit relationships thus bringing in dishonour for the family. In fact, fear of loss of women's chastity and modesty as a result of their stepping outside their boundaries was a recurrent theme among those who criticised the attempts to reform. They harped upon the fact that there was less adultery in the native society because women were kept in the inner quarters. Some of these educated *bhadralok* were concerned that the male attitude needed to be conditioned first in order to create a space where women could safely participate in the outer world. Women's foray into the prayer meetings of Brahmo Samaj by participating openly not only created tensions within the

Samaj, educated section also cautioned about this move. Those in favour of this liberation move suggested the presence of a man of noble character to chaperone the ladies [36].

Development of the feeling of nationalism led to the inculcation of physical culture among male while the female were encouraged to develop their mental strength. In this project, women were encouraged to inculcate qualities of chastity, modesty, self-control and sacrifice and disseminate the same among their male counterpart and especially to their sons, the future citizens of a degenerate nation to be delivered [37]. This attitude found their voice in the letters and articles sent to the newspapers. It hinted at the futility of 'women's emancipation' endeavour since the Indians themselves were under the clutches of foreigners, hence 'subjugated'. "...when we are, subjugated, weak, unable to protect our individual honour, then by providing education to the female, how can we secure their honour?" [38]. Thus moral prescriptive texts were suggested for female that would impart a sense of knowledge and would increase moral strength. Such attitude also found expression in the addresses made by Keshub Chandra Sen to the *Brahmikas* of the Arya Mahila Samaj, a women's body within the Nababidhan Samaj. He advised them to cleanse their mind and soul by deliverance from temptations. That would make one truly independent in spirit [39].

At the same period, the perception and mentality of the progressive Brahmos regarding women's liberation was totally different. It came through in an issue of their journal, *Brahmo Public Opinion* of May, 1879. "In all civilised countries under the sun, ancient or modern, women formed and still form the life and soul of society...We cannot resist the waves of Western civilisation which English education has sent rolling against us....In order that we may begin, we must assign to our women, a fitting position in society. It won't do first to educate and then to emancipate them. The two must go hand in hand...We think the art of cooking and feeding, nursing and bringing up the children, superintending the household duties, is as much necessary part of a woman's duty as her intellectual and moral education. In fact without that education, she becomes incapacitated from performing these duties. It is a mistake to suppose that the study of mathematics, philosophy or any other science or literature unsexes her. On the other hand, the study of these subjects, renders her *the* more fit for that position farther, renders her the more fit for that position in society to which she has been by God designated" [40]

Conclusion

By the end of the nineteenth century, 'home' or 'griha' was emerging as a sacrosanct space untouched by the debilitating influences of western civilization prone to material comfort and dishonesty. Home was seen as an abode of purity, spirituality and calmness a marker of Indian civilization. Therefore, as the maker of this 'home' the women had a special role of nurturer and upholder of virtuous life. She should be the perfect mother and wife whose task was looking after the household properly, bringing up her children as also the seeker of virtues like chastity, sacrifice and self-control. Women should inculcate these qualities in their role as wife and mother. While the number of educated female was increasing and women were developing a public space for themselves, societ

became anxious to remind them of their duties assigned to them. Hence, there was a proliferation of moral tracts during this period mostly written by male as well as educated female. A kind of moral control was imposed upon them which manifested itself in the development of a new taste, reflected in women's literature written by female, creation of a new style of dressing, arrangement of household, new sense of hygiene, new forms of entertainment etc. Women's subjectivity came through in this endeavour when women began to imbibe the tastes of their patrons. On the one hand, they were emerging out of the confined space; on the other hand they became subjected to newer forms of control imposed by their husbands this time[41]. The control of the elderly aunts and mother-in-laws gave way to husband's influence in their lives, and thus a new concept of conjugality gradually developed. *Stri-swadhinata* or women's emancipation as envisaged by the Brahmos and other radical reformers reached a point from where all discussions of India's modernity emerged.

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Advice

Green Chemistry: Eco-friendly Alternatives for Chemicals in Synthesis and Industry

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Abstract

Green Chemistry is an entirely new approach based on some basic principles that reduces or eliminates the use or generation of hazardous materials in the design, manufacture and application of chemical products. Conventional syntheses involve the use of substances, reagents and conditions that simultaneously generate undesired substances and ultimately cause environmental pollution. It is always better to reduce or prevent the formation of waste than to search for a method for their disposal. Use of catalysts, ionic liquids as solvents, reactions in water or even under solvent-free conditions improved techniques and application of nanotechnologies have changed the outlook and today chemists are searching for energy efficient processes for old reactions following the basic principles of green chemistry.

Key words: Green chemistry, Designing safer chemicals, Safety, Efficient processes, Ionic and supercritical liquids, Catalysis, nanoparticles

Introduction

The twentieth century has been highly successful for the science of Chemistry and society has come to depend on the products of chemical industry to maintain our current standard of living and improve our quality of life. An index to economic development is greater consumerism, which necessarily is associated with greater production of materials and this in turn involves various chemical methods. This widespread manufacturing and application of chemicals have often resulted in an adverse impact on the environment causing pollution of rivers, lakes and even underground water, pesticide residues in food grains, water, vegetables and fruits, damage to ecosystems and depletion of ozone layer. Chemical industries, as a result of these factors, even after adopting various measures to control environmental pollution caused by them, have attained a tarnished image amongst larger sections of population, particularly in developing areas. Thus awareness of environment-friendly chemical processes termed as "Green Chemistry" has a global programme. The present article is to give an overview of the subject with few representative examples [1-6].

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Basic Principles

The phrase 'Green Chemistry' was first coined by the US Environmental Protection Agency (EPA) during early 1990s to promote innovative chemical reactions (and technologies derived therefrom) which reduce or eliminate the use of hazardous substances in the design, manufacture and use of chemical products. In order to do so certain basic principles as described below have to be followed:

1. **Prevention:** Methods used must minimize production or creation of waste.
2. **Atom Economy:** Methods used must convert maximum amount of materials and reagents used into the final product. It can be calculated as:

$$\frac{\text{MW of the desired substance}}{\text{Sum of MWs of all substances produced}}$$

3. **Less Hazardous Synthesis:** We should design synthetic methods that are inherently less hazardous to human health and the environment i.e. reactions are more efficient, easier and environmentally benign;
4. **Designing Safer Chemicals:** Design of safer solvents/chemicals and reaction conditions to reduce their toxicity and potential for accidents.
5. **Safety:** Syntheses are to be designed in such a way that uses of auxiliary substances like solvents or separating agents become unnecessary.
6. **Design for Energy Efficiency:** Reactions are to be conducted at ambient temperature and pressure as much as possible in view of economic and environmental impacts.
7. **Use of Renewable Feedstocks:** Wherever practicable feedstock or raw materials should be renewable rather than depleting.
8. **Minimization of Derivatives:** Steps involving blocking/de-blocking, protection/de-protection etc should be minimized (or avoided) as they involve additional materials and can generate waste.

R. W. Hofmann, the first President of The Royal College of Chemistry, London, stated in 1848 is just as relevant today as it was then: 'In an ideal chemical factory there is, strictly speaking, no waste but only product. The better a real factory makes use of its waste, the closer it gets to its ideal, the bigger is the profit.'

9. **Catalysis:** Catalytic processes are superior to stoichiometric reagents. (The 2005 Nobel Prize in Chemistry was awarded to three chemists, Yves Chauvin, Robert H. Grubbs & Richard R. Schrock, each of whom had played a significant part in the development of *metathesis*. Metathesis reactions involve the breaking and rearrangement of carbon bonds in the presence of specialized catalysts.)
10. **Degradation to innocuous products:** Chemical product(s) are to be designed so that at the end of their function they break down into innocuous degradation products and do not persist in the environment.

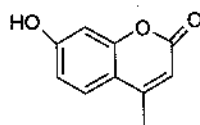
11. **Real-time Analysis for Pollution Prevention:** Analytical methodologies need to be further developed to allow for real-time, in-process monitoring and control prior to the formation of hazardous substances.
12. **Inherently Safer Chemistry for Accident Prevention:** Materials used in a chemical process should be chosen to minimise the potential for chemical accidents, including releases, explosions, and fires.

Main Categories

Examinations of the 'green' reactions have revealed that they constitute mainly the following categories:

- i) **Catalytic processes** utilize i) homogeneous ii) heterogeneous and iii) enzyme catalysis. Liquid biphasic catalyst viz. aqueous biphasic, supercritical carbon dioxide, ionic liquids are also used. Catalytic cascade processes involving both chemo- and bio-catalytic conversions have been explored [7]. Biocatalysts have a distinct advantage in that reactions all take place at or close to ambient temperature and pressure.
- ii) **Solvents:** To avoid the problems associated with many of the traditional volatile organic solvents, use of nonconventional reaction media is necessary. The toxic and volatile nature of many organic solvents, particularly chlorinated hydrocarbons, which are widely used in organic syntheses, pose a serious threat to the environment. Thus, to develop green synthetic methods efforts have been initiated in the following directions with particular attention to the industrially useful transformations:
 - a. No solvent is best solvent. Reactions occur on the surface of benign solid inorganic support without solvent. An example of synthesis of perfumery grade cyclohexyl esters from cyclohexene and carboxylic acid over ion-exchange resin with 100% atom economy has been reported by Yadav and Goel [8].

The synthesis of 4-methylumbelliferone with the help of a recyclable, solid catalyst, the acidic ion exchange resin Amberlyst-15, and under solvent-free

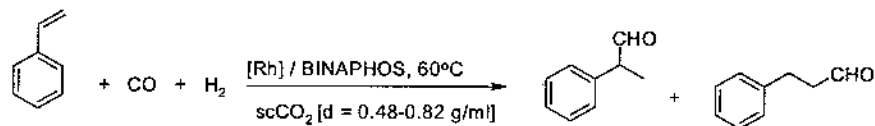


4-methylumbelliferone

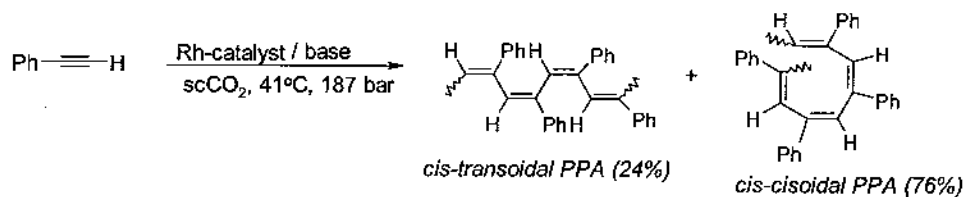
- b. Certain **supercritical (Sc) liquids and Ionic liquids** have found extensive use [6-13]. Benign properties associated with supercritical fluids are: high miscibility with reactant gases, high diffusivity, low viscosity, higher compressibility, non-toxic, non-inflammable, inert.

Several types of reactions can be conducted in supercritical CO₂ (scCO₂). Representative examples are shown below:

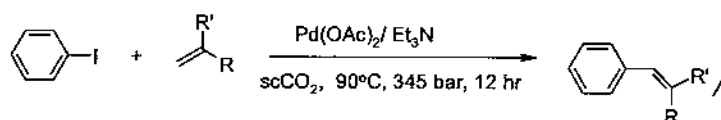
Asymmetric hydroformylation of styrene in scCO₂:



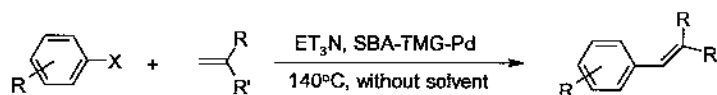
A Rhodium-catalyzed polymerization reaction for the synthesis of poly-phenylacetylene (PPA) in scCO₂:



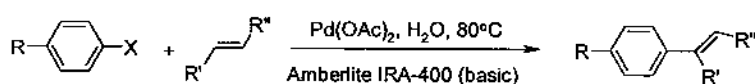
Heck reaction has been successfully carried out under different conditions, e.g. in scCO₂:



Following is an example of solvent free Heck reaction catalyzed by a recyclable Pd-catalyst supported on SBA-15 via an ionic liquid [14]:

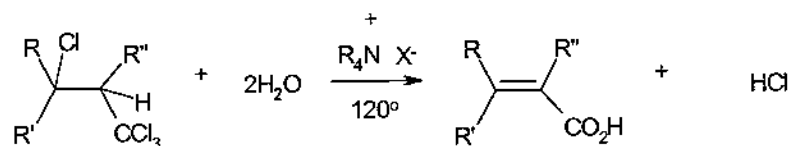


Efficient Heck reaction in aqueous medium using Amberlite IRA-400 (basic) as a base is also reported [15]:

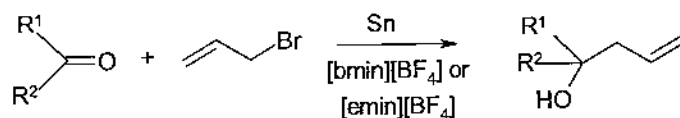


R = H, -Me, -OMe, X = Br, I
R' = H, -Me
R'' = -COOH, -Ph, COOMe, -CH₂OH etc

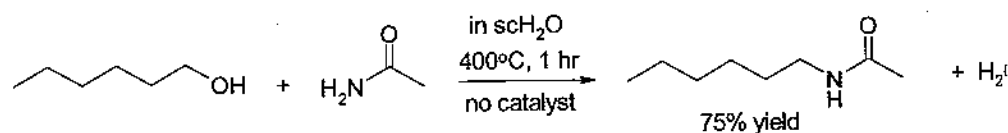
Novel, cheap and easy to prepare [16] quaternary ammonium ionic liquids have found dual use as solvent-catalysts for the synthesis of cinnamic acid:



Sn has been found to be metal of choice to mediate the allylation of carbonyl compounds in ionic liquids to give the corresponding homoallylic alcohols in good to excellent yields [17].

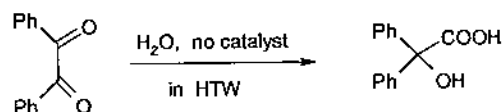


The hydroxyl group in 1-hexyl alcohol has been converted to an amide group in supercritical water without catalyst in very good yield [18]

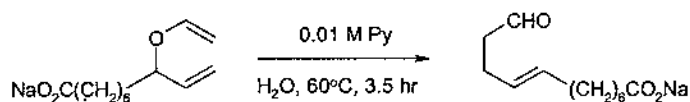
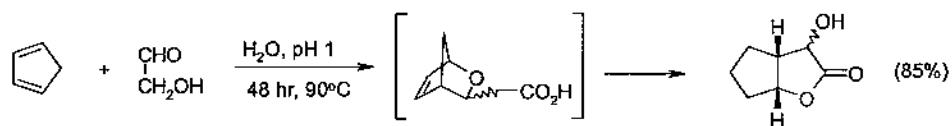


- c. Reactions in aqueous medium.** Water is a colourless, odourless, non-toxic, highly polar liquid and abundantly available. It is economic and at the same time poses no hazard for its disposal- a perfect green solvent. Some examples of use of water in organic reactions in various forms are shown below:

Benzil-benzilic acid rearrangement is a well known base catalyzed reaction in mixed solvents. But this reaction has been successfully undertaken in high temperature water (HTW), between 300-380°C, even without addition of base. Adding larger amounts of base, however, leads to higher yields and 100% selectivity to rearrangement products. The rearrangement is even autocatalyzed in HTW [19].

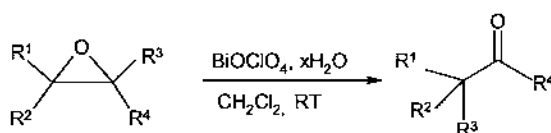


Most chemical reactions *in vivo* take place in an aqueous environment catalyzed by enzymes. It is now becoming increasingly clear that water not only enhances the rate of some organic reactions, but can also bring about a few which are impossible to realize under conventional conditions. Its high polarity facilitates the reactions which go through a polar transition state. Pericyclic reactions, such as, Diels-Alder cycloaddition and Claisen rearrangement benefit significantly when conducted in aqueous medium:



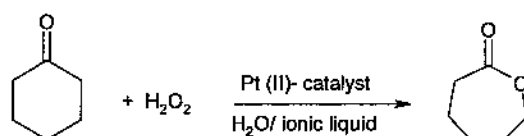
Claisen rearrangement

The use of Lewis acids like BF_3 (corrosive and air-sensitive), InCl_3 (highly toxic) has now been replaced by Bi (III) compounds which are fairly insensitive to small amounts of water. Thus $\text{BiOClO}_4 \cdot x\text{H}_2\text{O}$ is a very efficient reagent for high yielding, selective rearrangements of epoxides to carbonyl compounds:

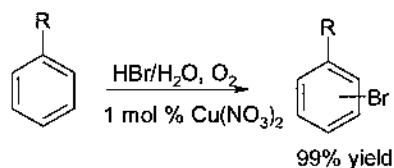


Epoxide	Reaction time	Product	Yield (%)
	25 min		90
	45 min		90
	45 min		90

Baeyer-Villiger oxidation of cyclohexanone with hydrogen peroxide has been found to take place with greater yield in water-ionic liquid mixture instead of chlorinated solvents [20].

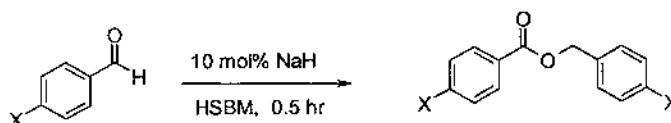


An aerobic oxybromination of arenes catalyzed by $\text{Cu}(\text{NO}_3)_2$ using HBr as a source of bromine, molecular oxygen as the oxidant and water as the solvent with high selectivity [21].

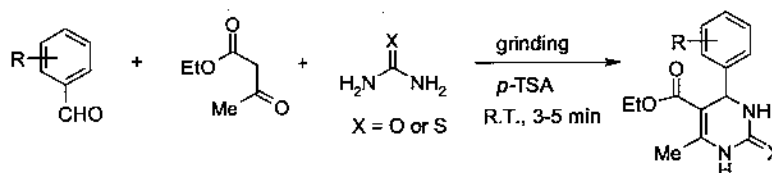


- d. **'Neat' reactions under solvent-free conditions.** We are familiar with the preparation of benzoic acid qualitatively by grinding and heating benzaldehyde with KOH without any solvent and subsequent work up.

Solvent-free Tischenko reaction of aromatic aldehydes have been undertaken in high yield using high speed ball mill and sodium hydride catalyst in 0.5 h [22].



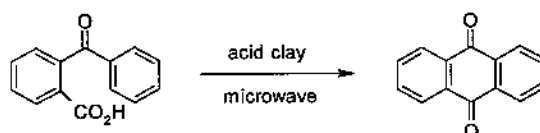
A very successful application of grinding of solids together for solvent-free chemical reactions has been demonstrated for conducting the multi component Biginelli reaction for the synthesis of physiologically active tetrahydropyrimidones [23].



- iii) **Microwave as Energy Source:** The microwave irradiation induced reactions [4,5,24] are fast and high yielding. Two techniques are generally employed – **MBR** (Microwave batch Reactor) and **CBR** (Continuous Microwave Reactor).

Some representative examples of solvent-free reactions under microwave irradiation are shown below:

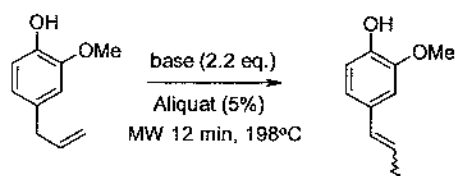
The industrially important raw material anthraquinone can be synthesized in a microwave oven from *o*-benzoylbenzoic acid in the presence of acid clay:



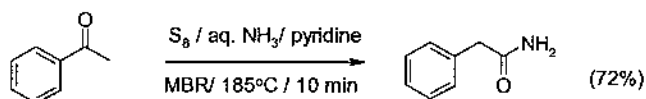
It is obvious that microwave assisted organic synthesis has several advantages over conventional technology as reactions are faster and cleaner.

Neat reaction in an open container:

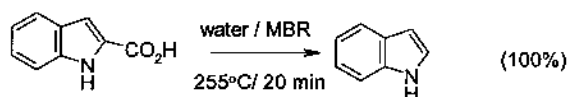
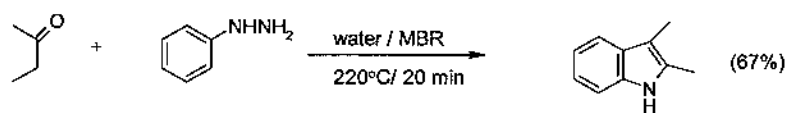
Isomerisation of eugenol:



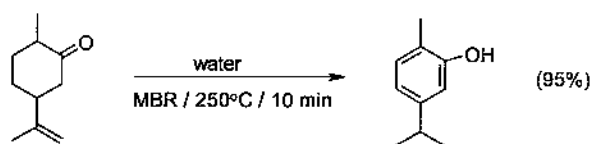
Willgerodt reactions can be completed within minutes rather than hours:



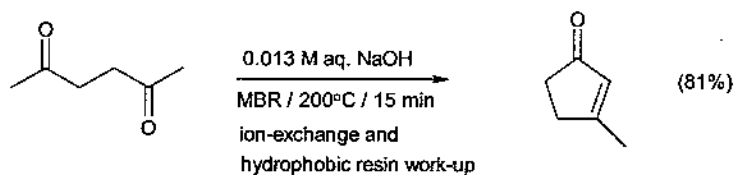
Indole can be prepared by one-pot reaction in water from phenyl hydrazine and butan-2-one:



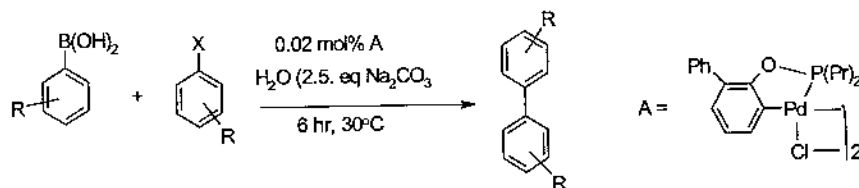
Carvacrol was prepared almost quantitatively, by isomerisation of carvone in water for 10 mins.



The preparation of 3-methylcyclopent-2-enone from 2,5-hexanedione can be done with microwave heating:

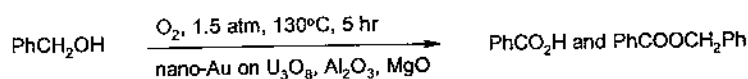


Environmentally friendly microwave-promoted Suzuki cross coupling reactions have been undertaken to prepare a variety of substituted biaryls in good yield very rapidly employing $\text{PdCl}_2(\text{PPh}_3)_2$ as catalyst and potassium carbonate as the base in water [25]. An improved protocol for the Suzuki-Miyaura reaction enables cross coupling catalysis in water and at ambient temperature employing a recyclable Pd-catalyst; products are obtained in high yield and excellent purity [26].

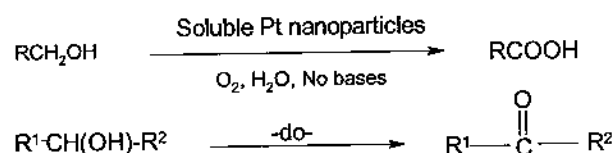


Application of Nanotechnologies:

It is known that matters exhibit novel properties when they are brought down to the size of nanometers (usually 1-100 nm). At the nanometer scale they exhibit significant catalytic properties which find use in the 'green' synthesis of many organic compounds. Generally silver, gold and platinum nanoparticles have been for such synthesis. Thus, Chlorine-free benzaldehyde can be obtained from a solvent-free liquid phase selective oxidation of benzyl alcohol by molecular oxygen using a reusable U_3O_8 , Al_2O_3 , MgO or ZrO_2 supported nano-gold catalyst [27].



Soluble Pt-nanoparticles have been found to be superior to Pd, Ru, Rh, Au-nanoparticles for aqueous-phase aerobic oxidation of alcohols without base [28]:



Spherically shaped Au(III)-nanoparticles catalyzed [3+2] dipolar cycloaddition of 1,6-allenylbenzaldehydes thereby offering a means of construction of polycyclic ring systems [29].

Homogenous Catalysis: In many conventional organic transformations like Friedel-Craft acylation, alkylation, nitration, halogenations, some molecular rearrangement reaction and even Diels-Alder reactions are known to be catalyzed by Lewis acids. Such reactions are generally undertaken in anhydrous conditions. But recently metal triflate ($\text{Tf} = \text{CF}_3\text{SO}_2$) have been used extensively to undertake such reactions in water (Scheme I). Generally Scandium triflate $\text{Sc}(\text{OTf})_3$, Ytterbium triflate $\text{Yb}(\text{OTf})_3$ and Hafnium triflate $\text{Hf}(\text{OTf})_3$ are used. Moreover, these triflates are required only in catalytic quantity and can be recovered also [30].

Scheme-I:

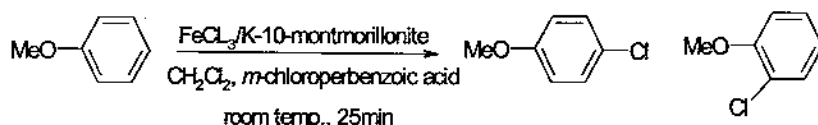
$$\text{Ar-H} + \text{Ac}_2\text{O} \xrightarrow[\text{LiClO}_4 (4 \text{ eqv}), \text{MeNO}_2, 50^\circ\text{C}]{\text{Sc(OTf)}_3 (0.2 \text{ eqv})} \text{Ar-COMe}$$

Substrate (ArH)	Product (ArCOMe)	Yield %
Toluene		47
Ortho-Xylene		55
Mesitylene		83

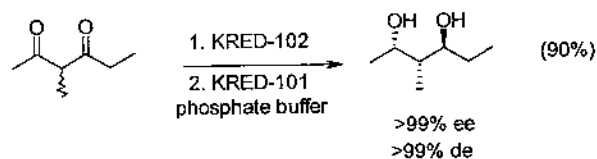
Benzene and its derivatives can be nitrated using rare earth triflates [such as La(OTf)_3] with a very high yield (benzene- 75%, toluene 95%, bromobenzene - 92%) [31].

A safe, practical and selective process for the aerobic oxidation of benzylic and allylic alcohols (including substrates containing *N*- and *S*-heteroatoms) to their corresponding aldehydes and ketones has been done using a Ru catalyst in a continuous flow reactor [32].

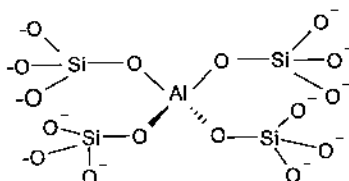
Heterogeneous Catalysis: K-10-montmorillonite (used in hydrocarbon cracking) is commercially available and is often used as a support for catalysis [33]. Clay supported ferric nitrate called 'Clayfen' is used for selective nitration of activated aromatic substrates (phenol gives >90% yield with good selectivity). Clay supported metallic chlorides have been used to undertake chlorination of activated aromatic substrate like anisole in the presence of an oxidizing agent, e.g.:



Enzyme catalysis has already occupied a significant position for its capability of specific biotransformation. Development in the field of genetic engineering is a key factor for its rapid growth and wide applications. Often a reaction is simplified by employing two microorganisms in succession. A stereoselective synthesis of optically pure 2-alkyl-1,3-dihols employing two enzymes in a cascade process has been reported. The process consists of two consecutive steps: a stereoselective diketone reduction and a hydroxy ketone reduction. Chiral diols were formed by the addition of ketoreductases in the same vessel, in high stereoselectivity and yield, without the isolation of the intermediate α -hydroxy ketones [34].



Zeolite catalysis has been claimed to be one of the future cornerstone of a clean, environmentally friendly organic chemical industry. Zeolites are crystalline aluminosilicates with exchangeable cations with a varying Si:Al ratio (1 to infinity). When exchanged with protons they become acidic solids. The number of acid sites decrease with increase in the Si:Al ratio while the strength of the acid sites increases with the Si:Al ratio. They have micro-pores of entry port size varying from about 3 to 12 Å formed by oxygen-sharing to Si or Al atoms; (Si/Al) are linked to four oxygen making tetrahedral units.



These units may form rings containing equal number of oxygen and silicon atoms. The rings share common oxygen (or silicon) forming different polyhedral which then join by sharing common oxygen (or silicon) forming the three dimensional network structure giving rise to pores, in one or several directions. The channel diameter in various types of zeolites in common use ranges from 0.74 nm for 'large-pore' Y-Zeolite to 0.41 nm for 'small-pore' A-type Zeolite. Advantages when used as catalyst are their – (i) possibility of recovering and recycling the catalyst (ii) high surface area: 400-500 m²/g (iii) reduction of pollution (iv) reduction of corrosion (v) regioselectivity as a consequence of shape selectivity.

This has found application in the synthesis of 3,4-dihydropyrimidin-2(1H)-ones [35]. Regioselective nitration of toluene by refluxing a slurry of n-propylnitrate, H-ZSM-5 as the catalyst gave *p*-nitrotoluene [36].

Conclusion

Though totally waste-free chemical processes are very difficult to realize in practice, the concept of 'eco-efficiency' is useful for optimizing chemical processes with the aim to minimize risk factor, resource depletion and waste generation. Design of more environmentally benign chemical manufacturing processes must now become an integral part of the development process. The resulting processes are not only greener but also better and often cheaper. While satisfying the needs and demands of the present generation we must not compromise the needs of the future generations. The remarkable technical innovations and expansion of knowledge in this century have resulted in enormous contributions to the world in the form of increased life span, food supply and general quality of life.

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Marie Curie: An Extraordinary Female Leader in Science

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Abstract

On 10 December 1911, Marie Curie was awarded the Nobel Prize in Chemistry for "services to the advancement of chemistry by the discovery of the elements radium and polonium". She was the first female recipient of any Nobel Prize and the first person ever to be awarded two. Such was Marie's impact on the scientific world and the role of women within it that one of the four stated goals of the 2011 international year of chemistry is to celebrate the centenary of her prize.

Keywords ? Marie Curie ? International year of Chemistry

Introduction and Rationale:

All known matter – gas, liquid and solid – is composed of the chemical elements or of compounds made from those elements. Humankind's understanding of the material nature of our world is grounded in our knowledge of chemistry. Indeed all living processes are controlled by chemical reactions.

The International Union of Pure and Applied Chemistry (IUPAC) and UNESCO strongly believe that *it is time to celebrate the achievements of chemistry and its contributions to the well-being of humankind*. At its General Assembly in Turin, Italy in August 2007, IUPAC unanimously approved a resolution in favor of the proclamation of 2011 as the International Year of Chemistry. Less than a year later, the UNESCO Executive Board recommended the adoption of such a resolution, submitted by Ethiopia, and which subsequently led to the declaration in December 2008 by the UN General Assembly of 2011 as the International Year of Chemistry. During the International Year of Chemistry, planned activities will:

- a. **Increase the public appreciation of chemistry in meeting world needs-** Chemistry, appropriately called the *Central Science*, is both a deeply philosophical inquiry and an applied scientific endeavor. The science of chemistry is fundamental to humanity's understanding of the world and the cosmos. Molecular transformations are central to the production of foodstuffs, medicines, fuels, metals, i.e., virtually all manufactured and extracted products. Through IYC the chemical community will publicly celebrate the art and science of chemistry. Its major contribution to developing human knowledge and fostering a wholesome environment.
- b. **Increase interest of young people in chemistry -** In order to ensure that first-rate minds continue to be attracted to and challenged by the central science,

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IYC will underscore the role of chemistry in managing natural resources sustainably. In partnership with the United Nations, the International Year of Chemistry will make a strong educational contribution toward the goals of the UN Decade of Education for Sustainable Development, particularly in the key action areas of *health* and *environment*. National and international activities carried out during the International

Year will emphasize the importance of chemistry in helping to sustain the natural resource base for life.

- c. **Generate enthusiasm for the creative future of chemistry** – Humanity's understanding of the world is grounded in our developing knowledge of chemistry. Creative opportunities to discover exciting new principles and applications continually appear as our understanding of molecular properties grows. Chemists will play a key role in overcoming the challenges facing today's world, for example in helping to address the United Nations Millennium goals. A deep understanding of the science is essential for developing molecular medicine, for creating new materials and sustainable sources of food and energy.
- d. **Celebrate the 100th anniversary of the Mme. Curie Nobel Prize and the 100th anniversary of the founding of the International Association of Chemical Societies.** - The year 2011 marks the one-hundredth anniversary of the Nobel Prize in Chemistry awarded to *Marie Sklodowska Curie*, recognizing her discovery of the elements radium and polonium. Dr. Curie's achievements continue to inspire students, especially women, to pursue careers in chemistry. She was the first female recipient of any Nobel Prize and the first person ever to be awarded two. The year 2011 also marks the one-hundredth anniversary of the founding in Paris of the International Association of Chemical Societies to address the need for international cooperation among chemists and international standardization of nomenclature, atomic weights, physical constants, and scientific communication.

In this article I wish to explore the life of a chemical heroine, Marie Curie.

Discussion

Marie Curie (her original name was Marya Sklodowska) was born on November 07, 1867 in Warsaw, the capital city of Poland. She was the fifth and the last child of her parents Bronislawa and Vladislav Sklodowska. At the time of her birth, Poland had not been an independent country. It had been divided up among Austria, Prussia and Russia. Warsaw was in the part of Poland that was under the control of Russia. Czar Alexander II, the then Ruler of Russia. After the birth of Marie, her family's fortune deteriorated. Her birth led her mother to resign her position as a head of a school, where the family had resided until then. They moved to a boys' high school, where her father taught mathematics and physics. However, the Russian supervisor in charge of the school fired him for his pro-Polish sentiments. And subsequently he was forced into a series of progressively lower academic posts. Her mother after fighting for five years against tuberculosis died at the age of 42 in May 1878. At the time Marie Curie was 10 years old. In 1873, Sklodowski

lost his job. He was replaced by a Russian teacher. At about the same time he also lost most of his savings through an unwise investment in a scheme promoted by a brother-in-law. Sklodowski never forgave himself for losing the family savings in a bad investment. However, his children honoured him for nurturing them emotionally and intellectually. He read classics of literature to his children. He also exposed to the scientific apparatus he had once used teaching physics in school but now he had kept them in home as Russian authorities removed laboratory instruction from the Polish curriculum.

Marie did very well in her school studies. She was awarded a Gold medal at her high school graduation in 1883. While she was very good student in school but in her early days she did not show any startling characteristic to indicate that one day she would become the most famous woman scientist in the world. But she had a brilliant aptitude for study and a great thirst for knowledge. However, as being a woman, as mentioned earlier, she had no hope for advanced study in Poland of those days. So she along with her sister Bronya started attending the Floating University. The name 'Floating University' derived from the fact it was an illegal night school and its classes met in changing locations. This was to evade the watchful eyes of the Russian authorities. It was obvious that the education given by the Floating University could not be matched the education provided by any major European university which admitted women. However, Marie became familiar with progressive thought and also with new developments in the sciences. Both Marie and her sister nurtured a hope of going to Paris and study at the Sorbonne University. However, their father was not in a position to send them to Paris for higher studies. Bronya was earning some money by giving private tuition. Marie also tried to earn some money by private tuition but without much success. Both the sisters realized that individually they would not be able to earn enough money to enable them to go to Paris. So they decided that one of them will go first by pulling their resources together. But then they had to decide who would go first. Marie asked her sister to go first.

To earn money Marie decided to work as governess. In 1886, again she went to take up the job as a governess in a village which was 100 kilometres away from Warsaw. Her salary was 500 rubles a year. It seemed Marie liked the job here, as evident from her letter to Henrietta written on February 03, 1886. She established friendly relation with the family to such an extent that they supported Marie when she decided to teach some of the peasant children to read and write in Polish. It may be noted that such an activity was strictly prohibited in Poland. While working here she fell in love with the eldest son of the family, a mathematics student at the Warsaw University and they decided to marry. But her employers, the parents of the boy, absolutely refused to allow it. Though she felt humiliated at the turn of events she stayed in her post till her contract was over. This is because she knew her responsibility. She had to send money to her sister in Paris. In mid-1889 Marie came back to Warsaw. She had got an appointment in the house of some rich industrialist. After finishing this assignment she started living with her father. She again joined the Floating University. During this time she had also an opportunity for entering a laboratory for the first time. It was in an institute called "The Museum of Industry and Agriculture" which was teaching science to young Poles. At the time it was directed by

her cousin Joseph Boguski. The name of the institute was to mislead the Russian authorities. A museum would not arouse suspicion. It was here that she developed the taste for experimental research. Finally the moment, for which she was waiting, arrived. In November 1891, she set off for Paris. She had just turned 24. She travelled in the cheapest class on the three-day journey by rail. She enrolled at the Sorbonne University. She had to struggle hard in her studies. After finishing school she had been away from her studies for six years. She was mostly self-taught and so there were inheritable gaps in her knowledge. Moreover, though she had good knowledge of French but it was not the same technical French spoken by her fellow students and professors at the Sorbonne University. At first she lived in the home of her sister, Bronya, who married another Polish patriot, Casimir Dluski, whom she had met in Medical school. The Dluski's home, however, was an hour's journey by horse-drawn bus from the university. So Marie had to waste two hours a day of valuable working time. Moreover, the Dluski apartment was a meeting place for Poles, full of distraction from work. The young doctor was frequently called out to his patients in the middle of the night which meant disturbance of sleep for others. In the absence of visitors Casimir played the piano which was also a source of distraction for Marie from her studies. So within few months Marie moved to the Latin Quarter, the artists' and students' neighbourhood, close to the university here also, she had to struggle a lot. There was no comfort for her. But Marie was obsessed by her dreams. She was harassed by poverty. But she was proud of living alone and independently in a foreign country. She wanted to achieve something and she had so much confidence in herself that she knew that she would achieve the target one day. In a letter written during this period to her brother, Marie wrote: *"It is difficult for me to tell about my life in detail; it is so monotonous and, in fact, so uninteresting. Nevertheless I have no feeling of uniformity and I regret only one thing, which is that the days are so short and that they pass so quickly. One never notices what has been done; one can only see what remains to be done, and if one didn't like the work it would be discouraging."*

Irrespective of tremendous hardships Marie not only completed in 1893 her master degree in physical science but stood first. For her spectacular success she was awarded an Alexandrovitch Scholarship, worth 600 rubles, when she came to Warsaw for the summer. The scholarship was meant for an outstanding Polish student wishing to work abroad. The scholarship enabled her to return Paris and take the master degree examination in mathematics in 1894 after one more year of study. This time she stood second. It may be noted that Marie after getting her first paid employment returned her scholarship money 600 rubles to the Alexandrovitch Foundation so that they could use it to give another young student the same opportunity she had enjoyed. At Sorbonne Marie had the opportunity to hear some of the very well-known physicists and mathematicians like Marcel Brillouin, Paul Painleve, Gabriel Lippmann and Paul Appell. Before completing her mathematics degree Marie was commissioned by the Society for the Encouragement of National Industry to do a study, relating magnetic properties of different steels to their chemical composition. For this work she needed a laboratory where she could do the work. One of her acquaintances, a Polish physicist, M. Kovalski, Professor of Physics in the University of Fribourg, who was visiting Paris at that time suggested that Pierre Curie

might be able to assist her. Pierre, who had done pioneering research on magnetism, was Laboratory Chief at the Municipal School of Industrial Physics and Chemistry in Paris. So Marie met Pierre, a meeting that would change not only their individual lives but also the course of science. With Pierre's assistance Marie could find rudimentary lab space at the Municipal School. When Marie met Pierre, he was 35 years, eight years older than Marie.

Though Pierre was an established physicist, he was an outsider in the French scientific community. He was a dreamer, an idealist, whose sole aim in life was to devote his entire life in the pursuit of science. He was totally indifferent to recognition. The Municipal school of Industrial Physics, which he was heading, trained engineers. His research work concerned with crystals and the magnetic properties of bodies at different temperatures. With his brother he had discovered piezoelectricity, which means that difference in electrical potential is seen when mechanical stresses are applied on certain crystals, including quartz. Marie, too was an idealist. And like Pierre she had also an urge to pursue science single-mindedly. Pierre and Marie immediately discovered an intellectual affinity, which was very soon transformed into deeper feelings. Initially Marie had no plans to settle in France. After her success in her mathematics examination Marie returned to Warsaw for a vacation. She was not sure whether she would return to Paris or not. Pierre wrote her frequently. He argued strongly that by leaving Paris for good she would be abandoning not just him, but a promising career in science. Marie came back to Paris and in July 1895 and married Pierre. In 1896, Marie passed her teacher's diploma, coming first in her group. Their daughter, Irene, the future Nobel Laureate, was born in September 1897. Pierre persuaded the authorities for allowing Marie to work in the School's laboratory. In 1897, Marie decided to take a physics doctorate. Her choice of a thesis topic was influenced by two recent discoveries by other scientists.

In December 1895 Wilhelm Conrad Roentgen (1845-1923) had discovered a kind of ray that could travel through solid wood or flesh and yield photographs of living people's bones. Roentgen, who became the first Nobel Laureate in physics, dubbed these mysterious rays X-rays, with X standing for unknown. In 1896, Antonine Henri Becquerel (1852-1908), showed that uranium compounds, even if they were kept in the dark, emitted rays that would fog a photographic plate. This was an accidental discovery. He was trying to find out whether the new radiation discovered by Roentgen could have a connection with fluorescence. The scientific community initially ignored Becquerel's intriguing finding. Marie decided to make a systematic investigation of the mysterious uranium rays for her doctorate degree. As the topic was quite new she did not have long bibliography of published papers to read. Thus she was able to begin experimental work on them immediately. She had an excellent aid at her disposal, an electrometer for the measurement of weak electrical current. This new kind of electrometer was invented by Pierre Curie and his brother Jacques. It was based on piezoelectric effect. This device was very useful as she decided to determine the intensity of the radiation of uranium compounds by measuring the conductivity of the air exposed to the action of the rays. While working on this topic she discovered that thorium gives off the same rays as uranium. Thus she proved that uranium was not the only radioactive element. She also concluded that the strength of the radiation did not depend on the compound that was



Figure 1. Marie in her laboratory

being studied. It depended only on the amount of uranium or thorium present in the sample. This was a very surprising result. Because as we know different compounds of the same element have very different chemical and physical properties. But in case radiation given off by uranium and thorium it mattered only how much uranium or thorium a compound contained.

Based on her findings Marie concluded that the ability to radiate did not depend on the arrangement of the atoms in the molecules but it must be linked to the interior of the uranium itself and not to its interaction with something else. It had to be an atomic property. And from a conceptual point of view it is her most important contribution to the development of physics. That radioactivity was an atomic phenomenon was demonstrated by Rutherford and his pupils. After these discoveries Marie decided to study the natural ores that contain thorium and uranium. She found that two

uranium minerals, pitchblende and chalcocite, were more active than uranium itself so she hypothesized that a new element that was considerably more active than uranium was present in small amounts in these ores. Pierre, after being fascinated with new vistas that were opening up from Marie's research, gave up his own research into crystals and symmetry in nature and joined Marie in her project. They found that the fraction containing bismuth or barium showed strongest activity. By the end of June 1898 they found a substance which was 300 times more strongly active than uranium. In this research paper announcing their findings they wrote: *"We thus believe that the substances that we have extracted from pitchblende contain a metal never known before, akin to bismuth in its analytic properties. If the existence of this new metal is confirmed, we suggest that it should be called polonium after the name of the country of origin of one of us."* The term 'radioactivity' was first used in this paper read on December 26, 1898. They announced the existence of an additional very active substance that behaved chemically almost like pure barium. They suggested the name 'radium' for the new element. In their joint work Pierre observed the properties of the radiation while Marie, for her part purified the radioactive elements. It turned out that in order to extract even tiny traces of radium one would require to process tonnes of the ore, pitchblende. Moreover Curie would require to buy this costly raw material. Pitchblende was expensive because uranium salts produced from it was used in industry to make glazes. But luckily for Curies the residue of the ore after the uranium had been extracted was almost worthless and could be brought cheaply. Being persuaded by Professor Edward Suess (1831-1914) and the Academy of Science of Vienna, the Austrian government which was the proprietor of the state factory, presented a ton of residue to the Curies. And what is more if they require more they could obtain it at the mine on the best terms. However, they had to pay for its transportation from Austria to Paris. They processed it in a dilapidated shed

While describing about the shed Eve Curie wrote: *"The Faculty of Medicine had formerly used the place as a dissecting room, but for a long time now it had not even been considered fit for a mortuary"*. There was no floor and an uncertain layer of bitumen covered the earth. It was furnished with some worn kitchen tables, a blackboard which had landed there for no known reason, and an old cast iron stove with a rusty pipe. After struggling under the most adverse circumstances, Marie finally isolated almost pure radium chloride. She had just obtained one tenth of a gram. She took it to the French chemist Eugene Demarcay (1852- 1904), who had first identified the new elements spectroscopically. He now had enough to determine its atomic weight, which he calculated as 225.93.

Marie defended her doctoral thesis on June 15, 1903. Among the three members of the Examination committee were two future Nobel Laureates - Gabriel Lippman (1845-1921) and Ferdinand Frederic Henri Moissan (1852- 1907). The Committee was of the opinion that the findings represented the greatest scientific contribution ever made in a doctoral thesis. The same year Marie and Pierre were awarded half the Nobel Prize in Physics *"in recognition of the extraordinary services they have rendered by their joint researches on the radiation phenomena discovered by Professor Henri Becquerel."* The other half went to Becquerel for his discovery of spontaneous radioactivity. The announcement of 1903 Nobel Prize for physics aroused tremendous curiosity of the press and the public. Earlier only the Prizes for Literature and the Peace used to be widely covered by the press. The Prize in science were not given publicity because they were considered all too esoteric to be able to interest the general public. After getting the Nobel Prize Marie wrote: *"We have been given half of the Nobel Prize. I do not know exactly what that represents: I believe it is about seventy thousand francs for us, it is a huge sum. I don't know when we shall get the money, perhaps only when we go to Stockholm. We are obliged to lecture there during the six months following December 10th. We did not go the ceremonial meeting because it was so complicated to arrange. I did not feel strong enough to undertake such a long journey (forty-eight hours without stopping, and more if one stops along the way) in such an inclement season, in a cold country and without being able to stay there more than three or four days : We could not, without great difficulty, interrupt our courses for a long period. We are inundated with letters and with visits from photographers and journalists. One would like to dig into the ground somewhere to find a little peace. We have received a proposal from America to go there and give a series of lectures on our work. They ask us how much we want. Whatever the sums may, we intend to refuse."*

On April 19, 1906 Pierre while hurrying to cross a road he was run over by a horse-drawn wagon with a load of military uniforms, weighing some six tons. He was killed instantly. The top of his skull was crushed by the left rear wheel of the vehicle. After Pierre's death, Marie was appointed as a professor at the Sorbonne University. She was the first woman to be appointed at Sarbonne. Marie continued to produce several decigrams of radium chloride. And finally with Andre Debierne, she isolated radium in metallic form. In 1911 she was awarded the Nobel Prize in chemistry *"in recognition of her services to the advancement of chemistry by the discovery of the elements radium and polonium.* The discovery and isolation of radium is regarded as the greatest event in chemistry since the discovery of oxygen. The fact that an element could be transmuted into another element

revolutionized chemistry and signified a new epoch. Some people have questioned the decision of the Nobel Committee awarding Marie a second Nobel Prize in chemistry. According to them, the second award was also given for the same discovery, for which Marie and her husband Pierre was awarded the Nobel Prize in Physics in 1903. In her Nobel lecture delivered on December 11 in Stockholm, she declared that she also regarded this prize as a tribute to Pierre Curie. In 1914 Marie helped found the Radium Institute. Throughout the first World War Marie devoted herself to the development of the use of X-ray radiography. She trained army's radiologist nurses at the Radium Institute, at what is now known as the Curie Institute. She equipped more than 20 vans that acted as mobile field hospitals and about 200 fixed installations with X-ray apparatus. She obtained funds from charitable institutions such as the Red Cross and adopted X-ray equipment to make portable radiology units. She persuaded rich women to donate cars to carry those instruments. Marie travelled with one of the cars herself operating the X-ray equipment at field hospitals to locate shell fragments in the bodies of wounded soldiers. Her elder daughter Irene helped her in her effort. Together they trained 150 other radiographers. The total number of men examined by these installations exceeded a million. After the end of the war, Marie undertook a campaign to raise funds for the Radium Institute. She was persuaded by Marie Maloney, an American journalist, to tour the United States for publicising the project in 1921. Maloney herself campaigned to raise funds from American women to purchase a gram of radium for Marie. The ten United States' President Warren G. Harding presented her the radium thus purchased. On July 4, 1934 Marie died of leukemia. She was 67. The leukemia was caused by her long exposure to hard radiation. In April 1995 Marie and Pierre Curie's remains were enshrined under the famous dome of the pantheon in Paris alongside the author Victor Hugo, the politician Jean Jaures and the Resistance fighter Jean Moulin. The Pantheon is the memorial to the nation's great men". Here some of the France's most distinguished personalities lay buried. Marie was the first woman to be honoured on her own merit. It may be noted here though Marie and Pierre worked under the most adverse circumstances they refused to consider taking a patent as being incompatible with their view of the role of researchers. If they had taken a patent it would have facilitated their research and spared their health.

Concluding Remark

We would like to end this article by quoting what Curie had to say for making a better world: *"You cannot hope to build a better world without improving the individuals. To that end, each of us must work for an own improvement and, at the same time, share a general responsibility for all humanity, our particular duty being to aid those to whom we think we can be most useful."*

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The conspiracy of Silence and the Calcutta Chronotope as a narrativizing strategy in *The Calcutta Chromosome*

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Abstract

This paper studies Amitav Ghosh's award winning fiction *The Calcutta Chromosome* with the help of the cognitive discipline of narratology— study of narratives with respect to their nature, form and functioning. By focusing on two primary questions asked with respect to any narrative, “why narrate?” and “how to narrativize?” the paper will look at the ways in which form and content have been silently wedded in this text i.e. the ways in which the text self references its own narration. Looking at the fundamental strategy of situating the text in the space-time zone of Calcutta and an attempt at reworking malariology, it studies Ghosh's take on the fundamental problem of post-colonial studies—can the subaltern speak? In doing so, it explores the ways in which the twin concepts of knowing and telling have been investigated as well as the impossibility of cognitive certainty. This is in tandem with the post-modern approach against positivism and its heavy dependence on micro-narratives. The paper concludes by looking at the ways in which silence has been used by the text as resistance to the moribund state of domination.

Key words: narratology, chronotope, malariology, colonization, interpersonal transference.

Introduction:

Amitav Ghosh recently delighted readers with his sequel to *The Sea of Poppies*, called *River of Smoke*, thus advancing towards greater and greater expertise in the writing of Indian fiction in English. If awards are any indication of things to come, they indicate the coming of age of Indian English writing (fiction and non-fiction) as nothing else does. Years back, Ghosh had silently bagged the Arthur C. Clark award for science fiction for his novel of fevers, delirium and discovery—*The Calcutta Chromosome*— and many accolades, if not awards for his interesting non-fictional writings like *In An Antique Land* and *Dancing in Cambodia*, born out of travels in the Middle East during a field trip for a doctoral thesis in anthropology. That wheel has come full circle with a recent Pulitzer prize for non-fiction, awarded to Siddharth Mukherjee for *The Emperor of All Maladies*. The scenario being such, a rewarding narratological study may be undertaken to uncover Ghosh's style and technique of narration in *The Calcutta Chromosome*.

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Narratology in brief:

Narratology[1] has long delved into the depths of fiction to come up with the most surprising explanations for the success or failure of a text and has been widely used as a reading tool for postmodern fiction. Using 'narratology' as a cognitive tool I would undertake to read *The Calcutta Chromosome* with an aim to examining the machinery that makes this text tick. So, this paper aims to accomplish two objectives; first it re-establishes the claim of contemporary theory of narrative desire being an essential prerequisite of the human condition i.e. it tries to answer the questions "Why at all narrate? Why listen to narration?" Secondly, and more importantly, it examines the role of time as an essential narrativizing device towards emplotment as a goal, i.e. it answers the question, "What constitutes narrativity[2]? How to narrativize[3]?"

Summary of text:

Situated vaguely somewhere in the future, Antar, an employee of LifeWatch, a sub agency of The International Water Council, comes across a digitized image of an old ID belonging to Murugan, an old acquaintance, on AVA, his workstation for working from home installed by LifeWatch. Beginning an external analepsis[4] Antar[5] relates Murugan's adventures in Calcutta of the 1990's. This hurls the text toward its core hypothesis of the Calcutta Chromosome. According to Murugan, there is a secret history of Ronald Ross's serendipitous discovery of the mosquito vector[6] for the malaria plasmodium. This history, so boldly narrativized in the text may seem far-fetched and hyper real but we should remember that in writing a medical thriller on malaria research Ghosh was not only turning the genre on its head but also questioning the empirical foundations of Western Science since Enlightenment. Enlightenment rationality posits a linear, out-there reality, the cognition of which becomes a norm with the natural sciences. Ghosh, whose interest in the cognitive sciences is well known, slips in a notion of Counter Science, which refutes the possibility of cognition and proposes a paradox. Knowing something is impossible because the moment we know something we change it thereby bringing about a mutation in phenomena so that to attempt to know something is merely to hurl it into the darkness of unknowability. The horizons of knowledge thus receding farther and farther into the unknown, we simply know what has already been and never what actually is at any given moment. This knowledge, of which we may claim acquaintance at a given moment, is always already moving ahead. Using this argument as a point of reference the counter scientists who had stumbled upon the discovery that malaria has a potential of hope for patients even in the terminal stages of syphilitic dementia[7] were on the verge of making a very important leap in the direction of immortality brought about through interpersonal transference. They had discovered that malaria "does stuff to the brain that we are still left guessing at". Their only requirement is now a mutation in the Chromosome which had undergone changes under the bout of malaria. This mutation they themselves, being secret-cultists, couldn't bring about on account of their principle of non-interference and their firm belief in the impossibility of knowing. This was where Ross's malaria research became relevant. Ronald Ross, Sergeant Major in the service of Her Majesty's army to India, was guided every step of the way towards discovery of the malaria vector leading to his winning the Nobel, so that he could bring about the

desired mutation in the malaria vector thus unawares registering himself as an emissary of the quest for immortality. If necessity is the mother of invention Ross's solution to the malaria puzzle was not born of the colonial crisis of malaria but the fact that his discovery was intended as a stepping stone to another, more formidable crisis, that of mortality of humankind.

History or fiction?

So what is narrated in *The Calcutta Chromosome* is a revision. It is a retelling of the narrative of a Nobel Prize winning discovery with the help of a personal narrative, that of a malarial, delusional narrator which wins a Prize for science fiction. In subverting a dominant colonial narrative with the help of a personal micro-narrative the author has not only questioned issues of prioritization but by drawing attention to the techniques of his own narration he has managed to shift awareness to the fictional nature of historical narratives. Among the recent theorists of narrative the historian Hayden White[8] has pointed out the close relations between literature and history and underlined the rhetorical underpinnings of narrated and non-narrated history. A Western obsession with beginning middle and end ends up imposing structural principles on the chaos of historical experience. And as far as the issues of prioritization are concerned, the narrative that convinces most gets the most priority and that too, is *la conditione humaine*.

It is now time to answer the question 'Why narrate and why listen to narration?'

Origins of a narrative:

Every narrative originates in desire. Human language is bound to desire. Every speech act is a performance aimed at fulfilment of a desire. Desire is always there at the beginning of a narrative, says Peter Brooks in *Reading for the Plot: Design and Intention in Narrative*:

'Desire is always there at the start of a narrative, often in a state of initial arousal, often having reached a state of intensity such that movement must be created, action undertaken, change begun...One could no doubt analyze the opening paragraph of most novels and emerge in each case with the image of a desire taking on shape, beginning to seek its objects, beginning to develop a textual energetics.'(p.38)

The Calcutta Chromosome initiates the textual energetics of a quest with the words: 'If the system hadn't stalled Antar would never have guessed that the scrap of paper on his screen was the remnant of an ID card.'(p.1) The dialectics of choice having been presented, the first sentence rests the burden of desire on the reader's shoulder. The reader has to abandon the false trail of what would have happened if the system hadn't stalled. If the system hadn't stalled Antar wouldn't have had to take cognizance of the object on his screen. Evidently the imperative to narrate in *The Calcutta Chromosome* has its genesis in Antar's desire to know himself, a prototype of one of the many mythic semes[9] that Vladimir Propp isolated amongst folktales[10], a spiritual quest. The text repeatedly plays with the idea of knowledge, of self and others, and shows the search to be a frustrated one, from the beginning to the end. Narratives not only originate in this spiritual quest, they go on interminably in their failed attempts to know the self through the other and the other through the self. Antar embarks on a quest to know himself with the remnant of Murugan's ID card. Generating an identity

for Murugan, Antar's narrative leaps right into the chaos of Murugan's own experiences which are shaped by experiences of Urmila and Sonali, characters twice removed from truth so to speak because they belong to the narrative within the embedded narrative of Murugan. The farther Antar delves into these narratives, the farther he travels from the centre of the tale, his one-to-one rebound world with AVA. It takes him to the centre of the antique world, of the colonizer and the colonized where he experiences, through Murugan's hypothesis, a literal displacing of the centre by the peripherals. This shapes his own narrative; having experienced that displacement he can no longer experience himself as being centred, becomes eccentric and narrates his own tale from the periphery, as it were, of his own life. This is the significance of his being 'helped across'; narrating his tale from outside the tale.

The circularity of narration:

'A story,' says Teresa de Lauretis, 'is always a question of desire'.(Lauretis,p.112). Having initiated the chain of desire the author goes on to address the *Other*[11] (as in psychoanalysis) through the narrative which is a mark in the interminable narrative matrix of which the subject is a construction. Narratologists have pointed out that the desire to narrate arises out of a fundamental drive towards signification, '...the engagement of the subject in certain positionalities of meaning and desire.' (Lauretis,p112) So compelling is this situation that to narrate or not to narrate is never a valid choice. Using the metaphor of a rattle snake Ursula Le Guin proposes that there is no alternative to the use of a narrative. The situation of narrative exchange is an imperative of the human condition; we must situate ourselves in the narrative matrix as a precondition of our inter-subjective experience. 'Even as we die from it,' comments de Lauretis, as she analyses the existential crisis that this leads us toward, 'just in order to exist or to sustain desire even as we die from it.' Le Guin writes:

'When a hoop snake wants to get somewhere—whether because the hoop snake is after something, or because something is after the hoop snake—it takes its tail (which may or may not have rattles in it) into its mouth, thus forming itself into a hoop, and rolls...They are venomous snakes, and when they bite their own tail they die, in terrible agony, of snakebite. All progress has these hitches. I don't know what the moral is. It may be in the end safest to lie perfectly still without crawling... Indeed, it's certain that we shall all do so in the end, which has nothing else after it. And the moral of that is, you have to *form a circle to escape from the circle.*' (pp189-90) To form a circle to escape from the circle is to narrativize. To narrativize is to impose structural principles on the chaos of experience. To impose structural principles is to situate oneself within a narrative matrix and temporalise. Time is the dimension which helps narrativize the homogeneous flow of experience. Every act of narration is a mark in the interminable matrix of narrative and every narrative mark responds to some other narrative mark and is responded to by the same. Lacan notes that, 'There is no speech without a reply even if it is only met with silence.'(Lacan,Jaques. *The Function and Field of Speech and Language in Psychoanalysis*.London: Routledge, 1995.p40) But time alone cannot determine the narrative mark which must be produced or received as an existential choice.

What is a Chronotope?

So the concept of space is also taken into consideration to complete the extra-temporal

dimension of a narrative and as a narrativizing strategy. Together these two entities constitute what Einstein called space-time and what Bakhtin calls 'chronotope', borrowing the concept from Einstein:

'We will give the name *chronotope* (literally, 'time-space') to the intrinsic connectedness of temporal and spatial relationships that are artistically expressed in literature. This term (space-time) is employed in mathematics, and was introduced as part of Einstein's Theory of Relativity...it expresses the inseparability of space and time (time as the fourth dimension of space). We understand the chronotope as a formally constitutive category of literature...' (M.M.Bakhtin, 1981,pp84-5)

Bakhtin goes on to categorise the typical chronotopes beginning with classical literature. He analyses the chronotope of the adventure romance or in other words the chronotope of encounter which includes the chronotope of the road. Bakhtin's study of the chronotope of the road, especially in Picaresque and novels of travel is a fascinating one. So is the next category of the Gothic novel which, according to him employs the chronotope of the castle as the very core of its genre. Further along the line Bakhtin goes on to explore the Biographical and Autobiographical novels which put to use the chronotope of the public square and the chronotope of the boudoir respectively. He also examines the chronotope of the idyll in the novel.

Taking the cue from Bakhtin we may now examine the chronotopes that compose *The Calcutta Chromosome*. The novel begins with the chronotope of the digital world. This world is virtual giving rise to two different time sequences in the text; one real and the other virtual. In the real-time of the novel Antar is sitting in front of AVA performing the many tasks required of him as a LifeWatch employee. In this real time of the novel we cover only a few hours, between which Antar embarks on a quest and comes to fulfil his destiny. Virtual time however, goes forward and backward in a telling rhythm. The two sections of the novel, covering 'August 20: Mosquito Day', and 'The Day After' belong to the secondary fabula of the text, i.e. Murugan's visit to Calcutta in 1995 and the two days of his visit on which Antar's delirious flashback is based. Virtual time includes much more. It includes the colonial period of Ronald Ross's life, Mme Salminen's séances, Phulboni's hallucinations, Farley's encounters with Mangala and Laakhan and Mrs.Aratounian's nursery where Urmila meets Sonali for the first time.

Both in the real and virtual world the chronotope of the railway road is given to enact a crucial role. Railway stations are great places, not only to pick up sweeper women and dhooley (a chair cum carriage) bearers as we learn from Sergeant Major D.D. Cunningham, victim of Silence later in the tale, but also for most of the supernatural action in the tale. The first of many such incidents happens in chapter 13 with J.W.D Grigson whose diary entry describes his encounter with Lutchman. A devoted crusader of the language registers and dialects of India, Grigson sports a healthy interest in Lutchman's origin and tries to trace it through the nuances of his pronunciation. But the counter-scientists resist any invasion of privacy. This acts as a detonator tripping Lutchman's (or Laakhan's) self-defence off so fiercely that he almost leads Grigson to his death under a train by the railway tracks belonging to Secunderabad railroad junction. Culpable homicide is not new to the tale and

every ounce of mystery and supernatural possible is squeezed out of the chronotope of the railway station. A standard issue railway signal lantern assumes sinister dimensions: the manner in which the railway signal lantern draws men to their deaths is likeable to what is commonly known in Bengal as “aleya” (as opposed to *alo* = light; *aleya* is *marsh gas* resembling a moving light that many a hapless wayfarer has taken to be a ghost) or “nishir daak” (a popular tale of a circe-like ghost voice-impersonating a close relative and luring men or women away from the safety of their homes at night to fatal consequences).

Sergeant Major D.D. Cunningham may have recommended railway stations as great places to Elijah Monroe Farley to find servants, but he most certainly forgot to warn him about the potential dangers of being drawn to death near a railway station, especially when a person has penetrated the secrets of the counter-scientists. This is what happens to Farley, whose fate is left undisclosed at the end of Chapter 21. A tale reconstructed by AVA, at Antar’s behest, by accumulating bytes of information available in AVA’s digital world and running the same through a storyline algorithm to construct the semblance of a narrative, Farley’s story ends with his disappearance and remains as a ‘suspended answer’ in the labyrinth of the reader’s hermeneutic[12] journey through the narrative. Not till we arrive at the next railway chronotope in the text, that of Phulboni’s Renupur episode, is the question “*What happens to Elijah Monroe Farley at Renupur?*” answered, and how!

Let us now examine the suitability of the railway road chronotope for the entire plot of the text as demonstrated by Phulboni’s Renupur episode. Renupur becomes the Bermuda Triangle of the novel. The guard, Buddhu Dubey and Phulboni complement the triangle. A small sleepy station whose only claim to being a railway stop is a ‘signboard and a platform attached to a siding’, Renupur is located amidst ‘flooded fields, the still waters broken only by the careful geometry of bunds and embankments’. Only ‘an occasional distant curl of wood-smoke spiralling out of a thicket of trees’ indicates a habitation and Phulboni arrives as the sniggering urban gun toting fool soon to be taught the ways of the wilderness. Renupur is no city for unbelieving men; it is a gap in the time zone, a hole in the world through which men may fall at night, and Phulboni falls twice. In this world afloat in a hallucinatory horizon, Buddhu Dubey is an oxymoron. Buddhu in Hindi means fool and Dubey is abbreviation of Dwivedi (dwi=two; vedi=he of the Veda) or someone who has acquired the knowledge of two Vedas, in other words—a learned man. Learned fools are clearly unwelcome in Renupur; no wonder Buddhu Dubey is a ghost, as Phulboni is soon about to be enlightened. Renupur railway station in *The Calcutta Chromosome* is like the highway of Soyinka’s poems of Africa. Always hungry; always waiting. Throughout the novel encounters systematically defy labels and resist narration.

Phulboni’s Renupur incident explains, if any explanation is at all possible, Farley’s disappearance. He learns that a foreigner had been killed here many years ago and this takes the chronotope of the railway station forward towards the closure. The story gathers pace as it draws towards completion. Disclosures come rolling thick and fast. Urmila meets Sonali along with Murugan and they venture towards Mrs. Aratounian’s apartment. It becomes apparent that she had not only anticipated Murugan’s visit but also calculated a year ago an exact date for departure and being pre-cognitive as a secret cultist ought to be,

had entered Murugan's articles for surrender to the Russell Exchange. The penultimate chapter finds the trio (another triangle) rushing to the Sealdah station which is where Mrs. Aratounian and Phulboni have been reported to have ventured to board a train to Renupur at eight thirty of that evening. Their journey thus completes the chronotope of the railway station leading towards the final railroad chronotope of Renupur: a black hole in the novelistic space.

With respect to the meaning and significance of chronotopes Bakhtin writes in *Forms of Time and of the Chronotope in the novel: Notes towards historical poetics*:

"What is most obvious is their meaning for *narrative*. They are the organising centres for the fundamental narrative events of the novel. The chronotope is the place where the knots of narrative are tied and untied. It can be said without qualification that to them belongs the meaning that shapes narrative." (M.M. Bakhtin, 1981, pp243-7)

The Calcutta Chronotope:

If the plot of *The Calcutta Chromosome* seems a knotty affair, the knots of the plot are tied in colonial Calcutta of August 20, 1897 and untied in Calcutta of August 20, 1994 and the day after. Diverse events connected to malaria research are narrativized with the help of the Calcutta chronotope. Plotting can be seen as a neat circle; Ross's emotional accolade to 'million murdering death' functioning as a prologue and appearing as one of the many Para-texts that guide the reader to the core of the text. The historicity of August 20, Mosquito Day, situates the text both in time and space. Epiphany for Ross, this was the day in 1897 when he was rewarded with the sight of a plasmodium in the stomach wall of a mosquito he had dissected. Having struggled for two years for a sight of this parasite Ross promptly called August 20 Mosquito Day. It also inspired him to write one of the most memorable poems of his life.

In fact there are two Calcuttas in *The Calcutta Chromosome*: colonial and independent. The Calcutta chronotope becomes the meaning generating unit of the novel. A city with a rich and diverse colonial history it becomes the thread connecting the two different centuries between Ronald Ross and Murugan. Once upon a time capital of the British Empire, settlement began with Fort William in Calcutta. This is the same Fort William which in Ghosh's novel becomes the Centre for Alternative states. A quaint combination of tradition and modernity, Calcutta leaves behind nothing and embraces everything in its stride. This sentiment is echoed in Phulboni's eloquent waxing speech overheard by Murugan at the Rabindra Sadan. He correctly surmises that Calcutta's vocation is excess and that sets the mood for the Calcutta Chronotope in the novel. The notion of Silence is concretized in the tale with the help of this special time zone in the novel. Phulboni's exhortation to Silence to take him along is literalized at the end with Mrs. Aratounian condescending to be accompanied by him. The mysterious by-alleys of Calcutta (it was still *Calcutta* and not *Kolkata* when Ghosh's novel was published) and the workaday characters help to build the shrine of Silence in the novel. This is the city with teeming stories in every nook and corner which doesn't get heard except by the most perceptive listener. Only Urmila, who belongs here, and Murugan by virtue of his malady about which he must not tell, can enter the secret cohort in their moments of intimacy which gets barely told.

Silence:

Silence is conspiratorial. Not only do the colonized lack narrative agency, but granting the agency to the colonizer is shown to be full of pitfalls as the contradictions of real and apparent are made clear through this space-time zone. To narrativize the contradictions of real and virtual requires a time-space continuum where the dialectics of past and present, rich and poor, mainstream and occult, scientific and supernatural can be resolved. To rewrite malariology would require not only a thorough knowledge of colonial history, but the real challenge would be to persuade the reader that this could be an alternate reality. Convincing the reader is no mean feat and this is achieved in *The Calcutta Chromosome* with the help of a phenomenon called mimicry, underscored by Homi Bhabha in *The Location of Culture*.

The hypothesis at the centre of the novel merits some attention if this has to be understood. Calcutta of 1897-98 is the location of Ronald Ross's solving of the malaria puzzle. The experiments take place during the colonial period when Ross's credibility as a researcher is by virtue of his position in the service of Her Majesty rather than by merit. This allows him, as N.K.Rajalakshmi notes in her paper, to use natives in his experiments without acknowledging their contribution. Moreover, as she has rightly pointed out by citing Ashis Nandy in her paper, every instance of the colonial enterprise marks how science was put to the use of the state but never vice versa. Elijah Munroe Farley's encounter with the counterscientists in D.D.Cunningham's laboratory in Calcutta of the novel is a reversal of the power positions in the colonial enterprise. Here the two cultures—of the elite and of the street—vie for space. Initially they coexist; while Farley is viewing slides in Cunningham's laboratory a lot of counterscientific activity goes unnoticed in the ante-room. Only on day two does he notice, that too when several syphilitic patients are hovering around the lab, that Mangala and her helper cannot be slipped into neat straitjackets of sweeper woman and dhooley bearer. He is initially severely critical of their project:

'His conscience called out to him to go outside and tell them (the syphilitics) not to waste their hopes on whatever quackery it was that this woman offered; to expose the falsehoods that she and her minions had concocted to deceive those simple people. It was his duty, he knew, to tell them that mankind knew no cure for their condition; that this false prophetess was cheating them of money they could ill afford.' (Chapter 21) (Ghosh, 1996)

The ideological leanings of Farley's notions of 'quackery' become immediately recognizable. One of the false premises on which the colonial enterprise was based was the notion of progress and the white man's burden which were justified on the basis of the natives' savage practices. This included rituals of 'sacrifice'— animal or human, cannibalism, sexual excesses, rope-trick, magic, sorcery and witchcraft. Construction of the Oriental stereotype used to be a vindication of the Colonial master's unfounded rule over natives and their subjection. The Tall tower of Imperial project is especially conducive to short sights of several kinds one of which Farley is shown to suffer from. What happens behind his back and especially the incidents in the ante-room are presented to him through the reflection of the convex surface of a glass tumbler half full of water: 'It was soon clear that it was he, Farley, they were talking about: the *distorted* reflections of their faces seemed to take on a and *frightening* quality as they nodded and pointed across the room.' (Ghosh, 1996)

Mimicry and the mirror:

A mirror reflects reality. A convex mirror not only distorts reality but also eliminates distance; objects appear closer than they are. Farley's version of incidents in the ante-room is distorted and he is far from the truth. He doesn't, till Mangala the sweeperwoman explains it to him, understand the role of flagella in the malarial blood cell of pigeons. Not a quack, nor a 'false prophetess' Mangala is inimical to the stereotypes cast by the white male at the periphery of mainstream science. The location as well as the nature of counter scientific activity in the ante-room is a distinct form of mimicry, a concept recently introduced by the Indian postcolonial critic Homi K. Bhabha. Bhabha defined the bilateral cultural processes that transpired in the liminal spaces, or contact zones, of colonized societies as "mimicry." With this term he both sharpened and built upon a classic Western scholarly treatise. In 1946 the German literary critic Eric Auerbach published

in which he dwelt upon mimesis and the problems of representing reality in the verbal medium. 'In Auerbach's vision, mimesis embodied the pivotal challenge of writers throughout history, beginning with Homer's *Odyssey* and *Iliad*, of translating verbally and rendering in textual format observations made in the world of nature and in the realm of human interactions (Auerbach 1957). Bhabha has refocused this basic conundrum of Western literature in a different direction, however, by concentrating on the kinds of cultural exchanges and complementary interactions that occurred in the interstices of colonial societies, in what he calls the "overlap and displacement of domains of difference" (Bhabha 1994).' (Gouda,p4) Mimicry as Bhabha describes it is, "the sign of a double articulation; a complex strategy of reform, regulation and discipline, which 'appropriates' the Other as it visualizes power." (Bhabha, 1994,p122)

Caught in the domain of difference, colonialists' visions of the Other are reduced to a sad, grotesque distortion. Farley's description of the counterscientists' activities cannot measure up to the representational function of language in as much as it cannot represent a reality it cannot apprehend. His powers of description fail him, for whatever he *thinks* Mangala and Lakshman are doing, clearly they are not. And whatever they *are*, clearly Farley is unable to comprehend. "Through much of the night, for no reason that he could adduce, Farley prayed. Yet he could find no name for what it was that faced him and why he feared it." (Ghosh, 1996) And I quote Bhabha: "Despite their intentions and invocations (expressed in the colonisers' discourse) they inscribe the colonial text erratically, eccentrically across a body politic that refuses to be representative, in a (Bhabha, 1994,p126)

This domain of difference produces a discourse which is continuously challenged by what Bhabha calls its 'slippage, its excess, its difference'(Bhabha, p122). Moreover, mimicry can only *repeat* and not represent, as Bhabha points out. Accordingly, Farley's representation of Mangala and Lakshman's activities in the ante-room of Cunningham's laboratory seems nothing but a dead repetition of a ritual of sacrifice along with the proper antecedents of worship and obeisance. Mangala's manoeuvres are reduced to a form of mockery and mimicry under the diminishing perspective of the coloniser's vision. This is the diminishing perspective of the convex looking glass. Trapped in the irony of their own civilizing mission

the most that the coloniser will do is produce authorized versions of Otherness—whose meaning is permanently deferred. No wonder that in the last communication that Farley ever made, his letter to Colonel Opie as salvaged by Murugan from a library and whose reminiscence he later sent to Antar, Farley signs off by saying that “...everything is other than what it seems, a phantom of itself.” Sent to India on Her Majesty’s service, Farley’s dominant ideological discourse suffers a setback when confronted by a superior, seemingly ineffable power whose height he cannot fathom and which he is loath to acknowledge. What better device to stage this reversal than the Calcutta chronotope?

The project of interpersonal transference is staged in the Calcutta chronotope. Narration is paced slow or fast in accordance with period narrated. Old Calcutta is focalized through Farley while contemporary Calcutta is focalized through Urmila and Murugan. In fact narrated time in the Calcutta Chronotope is like the adventure time of Romance novels as elucidated by Bakhtin in *The Dialogic Imagination*, replete with chance coincidences and fortuitous meetings. Urmila’s *chance* meeting with Sonali and Romen at Dutton’s where she *accidentally* nudged Sonali and got a look at Romen’s thumbless palm by *chance*. Murugan meets Sonali and Urmila by *chance* in trying to avoid a downpour, having left his Cadillac of an umbrella back at the Robinson Guest House. This is where he gets to hear Phulboni’s speech trying to narrate Silence. On his way to the Ross memorial he gets followed by a mysterious youth who Murugan thinks is a hotel tout. In trying to dodge his strange pursuer Murugan stumbles upon a dumping ground behind P.G.Hospital and bracing himself against the wall his hand ‘*chanced* upon the rim of an opening in the rough brick surface’; a clay figurine, a probable model of the mysterious shrine of Silence is thus found. It would seem that inexplicable forces prod Murugan towards Mrs. Aratounian’s paying guest facility at Robinson Street: ‘Murugan had found the place entirely by *accident*’. And if the landlady staying up late with him and offering him gimlets didn’t strike Murugan as odd, the *sudden* departure of Mrs. Aratounian, bag, baggage, Murugan’s articles et al, serves as the final argument for a city of happenstance. The Calcutta Chronotope operates on two levels and through it the narrative oscillates between the twin desires to know and to tell.

The one level is the epochal event of Ronald Ross’s plasmodium discovery which is a historical truth and doesn’t require the accoutrements of a narrative to stand on its own. The other level—and this is where the Calcutta chronotope begins to narrativize—is the deeply lived nature of personal histories such as Farley’s fear and Urmila’s brief detour with Murugan into Kumartuli where they learn about the impending gala event of the secret cultists, and their intimate huddling in rain. What is narrativized is not some grand conspiracy theory built on suitable gaps in Ronald Ross’s unaccountable solution to the malaria puzzle, but ‘the ground essential for the showing-forth, the representability of events.’ (M.M.Bakhtin, 1981) As Paul Ricouer so rightly points out, ‘...time becomes human to the extent that it is articulated through a narrative mode, and narrative attains its full meaning when it becomes a condition of temporal existence.’ (Ricouer, Paul. *Time and Narrative*. Chicago: The University of Chicago Press, 1981,p52)

Bakhtin says: ‘Time becomes, in effect, palpable and visible; the chronotope makes narrative events concrete, makes them take on flesh, causes blood to flow in their veins.’ (Bakhtin, p125)

Time becomes human with the help of personal narratives like those of Urmila, Murugan and Sonali. These personal narratives legitimize the fraught life that Time lives in the novel. The Calcutta chronotope 'serves as the primary point from which scenes in a novel unfold, while at the same time other binding events, located far from the chronotope appear as dry information and communicated facts...thus the chronotope, functioning as the primary means for materializing time in space, emerges as a center for concretizing representation, as a force giving body to the entire novel.' (M.M.Bakhtin, 1981,p243-5) No wonder Mme Salmimen's séances in Madras and the inexplicable fever that wiped out a village with mud-thatched roof and creaking water-wheels in Egypt appear distant while incidents in Calcutta whether past, present or future seem nearer.

Conclusion:

The secret life of Time in the novel gains flesh with the help of this narrative space. Engaging the primary narrator in certain positionalities of meaning and desire (those that initiate the textual energetic of a quest after the ID), the story proceeds to narrativize two other quests, that of Ronald Ross for the plasmodium and that of Murugan after a cure for his syphilis, a debilitating condition to which is attached the social stigma of a sexually transmitted disease. No wonder the narrative shows signs of neurosis and talks endlessly about silence. These quests form a circle. Ross's malaria research; Wagner Juregg's use of artificially induced malaria to cure syphilitic dementia; the quest after the elusive Calcutta chromosome, are all foot soldiers marching to the clarion call of immortality. 'If we could only join the beginning and the end' sighs Ursula le Guin and that is precisely what the Calcutta chronotope does—joining the beginning and the end. Antar's tale is an open ended one, a beginning rather than an end with the grand narrative of interpersonal transference symbolising a death-defying act.

Antar's spiritual quest, trying to arrive at an awareness of oneself though others is shown to be a highly problematized one. Self-knowledge is systematically denied to most of the characters in the tale like Murugan, Urmila and Sonali. The narrative comes full circle with Antar's abysmal lack of self-knowledge. He feels feverish and it cannot be ascertained whether the voices in his head are real or an outcome of delirium. The tale is polarized with reference to twin concepts of knowing and telling. Those who tell do not know; those who know do not tell. The circularity of any quest for signification is emphasised time and again. The beginning and end are thus thematically joined in the conspiracy of Silence.

References

1. The roots of contemporary narratology lie in the work of French Structuralists. Issue number 8 of the journal *Communications* is usually taken as officially ushering in the discipline. This issue which came out in 1966 contained nine articles with proposals for various ways of studying narratives. Some of these articles are now classics. Study of plot by Roland Barthes, as well as other contributions by A.J.Greimas, Claude Bremond, Umberto Eco, Gerard Genette and Tzvetan Todorov have remained landmark articles. In his *Grammaire du Decameron* published in 1969, Todorov introduced the term "narratology": "We wish to develop a theory of narration here...as a result this book does not so much belong to literary studies as to a discipline that does not yet exist, let us say narratology, the

- science of narrative." (Todorov, 1969) French structuralists remain ingratiated to Russian formalists as precursors of this scientific field. Vladimir Propp's *Morphology of the Folktale* can be seen as an embryonic example of structuralist narratology.
2. The set of properties characterizing narrative and distinguishing it from non-narrative. Prince, Gerald. *A Dictionary of Narratology*. Nebraska: University of Nebraska Press, 1989.
 3. The degree of narrativity of a given narrative depends on the extent to which that narrative fulfils the receiver's desire by representing originated temporal wholes.
 4. Going back to the past with respect to the present moment in a given narrative. Prince, Gerald. *A Dictionary of Narratology*. Nebraska: University of Nebraska Press, 1989.
 5. The homodiegetic narrator.
 6. Ronald Ross discovered that the female anopheles mosquito is the carrier for the malaria virus and hence responsible for transmission of the malaria to humans. Since the medieval ages the occurrences of these mysterious tropical fevers were medically ascribed to foul air, hence the name *mal aria* or *bad air*.
 7. Syphilis, a much dreaded sexually transmitted disease, typically attacked the brain in its terminal stages. One learns from *The Emperor of All Maladies* that syphilis, diagnosed a venereal disease, was systematically treated with various mercurial toxins, a truly painful procedure, so that syphilis came to be known as "One night with Venus and a thousand nights with mercury."
 8. See White, Hayden. *The Fiction of Narrative*. John Hopkins University Press. Baltimore. 2010.
 9. An elementary semantic feature; a minimal unit of meaning. (Prince, *A Dictionary of Narratology*)
 10. Propp, Vladimir. *A Morphology of the Folktale*. Austin. University of Texas Press. 1968.
 11. To characterize a person, group or institution as *other* is to place them outside the system of normality or convention to which one belongs oneself. (J. H. ed.)
 12. (i) One of the many codes proposed by Barthes that according to him the reader usually employs in the process of formation of meaning and signification in the novel, Bal, Mieke. *Narratology: Introduction to the Theory of Narrative*. Toronto: University of Toronto Press, 2009 Third Edition; (ii) Barthes, Roland. *Image Music Text*. New York: Hill and Wang, 1977 and *The Pleasure of the Text*. New York: Hill and Wang, 1975; (iii) Bhabha, Homi K. *The Location of Culture*. London and New York: Routledge, 1994 — ed. *Nation and Narration*. New York: Routledge, 1990; (iv) Brook, Peter. *Reading for the Plot*. New York: Harvard University Press, 1992; (v) Culler, Jonathan. "Story and Discourse." ed, Martin Mcquillan. *Narrative Reader*. New York: Routledge, 2000. 104-108; (vi) Genette, Gerard. *Narrative Discourse*. London: Basil Blackwell, Oxford, 1980; (vii) Ghosh, Amitav. *The Calcutta Chromosome*. New Delhi: Permanent Black, 1996; (viii) Gouda, Frances. "Colonial Forms of Knowledge and the Process of Mimicry." *Journal of Colonial Studies* (n.d.); (ix) Luc Herman and Bart Varvaek. "Narrative Interest as Cultural Negotiation." *Narrative* 17.1 (2009): 111-129; (x) M.M.Bakhtin. *The Dialogic Imagination*. Texas: University of Texas, 1981 and "On Narratology (Past, Present, Future)." *French Literature Series (Columbia)*, 17.1 (1990): pp.1-2; (xi) Ricoeur, Paul. *The Rule of Metaphor*. Toronto: University of Toronto Press, 2008 and *Time and Narrative*. London: University of Chicago Press, 1990 ; (xii) Rimmon-Kenan, Shlomith. *Narrative Fiction: Contemporary Poetics*. New York: Methuen, 1983 ; (xiii) Todorov, Tzvetan. "Typologie du roman policier." *Poetique de la prose*. n.d. 57-59.

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4. L. A. Withers and F. Engelmann: In vitro conservation of plant genetic resources, **A. Altman** (ed.) *Agricultural Biotechnology*. Marcell Dekker Inc., New York, 57-58 (1998).
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ISSN 0976-9625

Price ₹100