Year long celebration of 150th Birth Anniversary of Sister Nivedita

Department of Higher Education, Govt of West Bengal sponsored Inter-Disciplinary State Level Seminar Series

September 28, 2016-February 21, 2017

On

Women Empowerment and Higher Learning: Revisiting the Perspectives of Sister Nivedita in this e-Era

Proceedings

Organized By

Sister Nibedita Govt. General Degree College for Girls
Hastings House, Kolkata-700027
contact@snggdcg.ac.in

ACADEMIC PUBLISHERS

Higher Education Department, Government of West Bengal Sponsored
Inter-Disciplinary State Level Seminar Series

(28th Sept, 2016 – 21st Feb, 2017)

On

Women Empowerment and Higher Learning: Revisiting the Perspectives of Sister Nivedita in this e-Era

Proceedings

150th Birth Anniversary Celebration

Hosted by

Sister Nibedita Government General Degree College for Girls

20B, Judges Court Road, Alipore, Kolkata – 700056, West Bengal, India
Contact nos.: +91 (033) 2479 7100; +91 (033) 2479 7110
Fax: +91 (033) 2479 7100
Email: contact@snggdcg.ac.in
Website: snggdcg.ac.in

ACADEMIC PUBLISHERS
Kolkata-700 073 • India
E-mail : contact@academicpublishers.in
Website : www.academicpublishers.in

First Published 2017

ISBN : 978-81-933395-0-3

Published by Academic Publishers, 5A Bhawani Dutta Lane, Kolkata, W.B., 700073, India.
Email: contact@academicpublishers.in, Web: www.academicpublishers.in.
Typeset and printed in India.

ড. পার্থ চ্যাটার্জী
ভারপ্রাপ্ত মন্ত্রী
উচ্চশিক্ষা, বিজ্ঞান ও প্রযুক্তি এবং
জৈব প্রযুক্তি বিভাগ, বিদ্যালয় শিক্ষা বিভাগ,
পরিষদীয় বিভাগ
পশ্চিমবঙ্গ সরকার
বিকাশ ভবন, সল্টলেক, কলকাতা - ৭০০ ০৯১
দূরভাষ ঃ ২৩৩৪ ৬১৮১/২২৫৬, ২৩৩৭ ৬১৭২
ফ্যাক্স ঃ ২৩৩৭ ৬৭৮৩/২৩৫৮ ৮৮৫৮

Dr. PARTHA CHATTERJEE
Minister-in-charge
Departments of Higher Education, Science & Technology and Biotechnology, School Education, Parliamentary Affairs
GOVERNMENT OF WEST BENGAL
Bikash Bhavan, Salt Lake, Kolkata - 700 091
Tele : 2334 6181/2256, 2337 6172
Fax : 2337 6783/2358 8858

No. – 131/MIC/HED, S & T, BT, SED&PA/17

MESSAGE

I am glad to know **Sister Nibedita Government General Degree College for Girls** is going to celebrate 150th Birth anniversary of Sister Nibedita by arranging a Year-Long State Level Lecture Series to commemorate the programme

I firmly believe that this occasion would keep all the members abreast of their field.

I wish a grand success and convey my best wishes to all concerned for their best effort.

Minister-in-Charge
Departments of Higher Education,
Science & Technology and Biotechnology,
School Education, Parliamentary Affairs.

Principal
Sister Nibedita Government General Degree College for Girls

Nabanna : 325, Sarat Chatterjee Road, Howrah-711 102, Room No. 101, Telefax : 2250 1157

Prof. Jayasri Ray Chaudhuri
Ph.D (Cartab. U.K.) WBSES

सत्यमेव जयते

DIRECTOR OF PUBLIC INSTRUCTION, West Bengal
EDUCATION DIRECTORATE
GOVERNMENT OF WEST BENGAL
BIKASH BHAVAN, SALT LAKE, KOLKATA-700091
Tel. : 2337 8269, Fax : 033 2337 8269
E-mail : dpijrc@gmail.com

Ref. No. ED-1720/2017

Dated 28.04.17.

Message from DPI

I am happy to know that the teachers, pupils and staff members of Sister Nibedita Government General Degree College for Girls, Hastings House, Kolkata have organized a year long program with special emphasis on **"Women Empowerment and Higher Learning : Revisiting Perspectives of Sister Nibedita in this e-Era"**., to pay their respect and sacred homage to Sister Nibedita on the golden occasion of her 150th Birth Anniversary this year. The entire program was observed in a befitting manner, with a wide array of seminars, discussions, poster presentations by the renowned Scientists, academicians as well as the students of the college to highlight the relevance of Nibedita's teaching in this digital era.

I convey my best wishes for the publication of the proceedings of the seminar on this occasion.

28.04.17.

Director of Public Instruction
Government of West Bengal

PREFACE

We, the Indians, shall never forget the unique personality, dedication and courage of a noble lady who came from far West more than a century ago, to serve our nation and dedicated her entire life for the service of mankind. She was none other than Sister Nivedita, the illustrious disciple of Swami Vivekananda and one of the pioneer educationists in late 19th century and early 20th Century India.

On the occasion of her 150th Birth Anniversary, we took the endeavour to organize a series of state-level seminar lectures during the period of 2016-17 with a view to pay homage to her. The entire programme, revolved around the cardinal theme "Women Empowerment and Higher Learning: Revisiting the Perspectives of Sister Nibedita in this e-Era", was financially sponsored by the Department of Higher Education, Govt. of West Bengal.

Students, members of teaching faculty and non-teaching staff of our college and colleges of adjacent areas had the opportunity to feel palpably the benefits and meaning of true education sought by that questing soul, "One who had been dedicated."

This present volume is enriched by the contributions from renowned scientists and other eminent dignitaries in many of the fields of basic and applied sciences, literature and culture. All these articles and papers described and analysed modern developments in the areas of Physical Science, Life Science, Social Science and Literature along with the relevance of teachings of Sister Nivedita and her mentor, Swami Vivekananda in the present e-Era.

I feel that the thought provoking articles in the present volume may quench our thirst for recent knowledge in many of the realms of Science, Literature and Education.

Professor (Dr.) Krishna Roy
Principal
Patron and Editor-in-Chief of the Seminar Series

ORGANISING COMMITTEE MEMBERS

Smt. Shuchismita Mitra, Department of English
Dr. Atanu Saha, Department of Physiology
Sri Bhaskar Das, Department of Physics
Smt. Arundhati Bhattacharya, Department of Economics
Sri Bholanath Pakhira, Department of Chemistry

DISCLAIMER

This is to certify that the contents given in the Manuscripts/Research papers have been produced in original as submitted by the Authors in Inter-Disciplinary State Level Seminar Series held at Sister Nibedita Government General Degree College for Girls.

The Editorial Board has not edited or deleted the contents. The Editorial board shall not be held responsible for authenticity of data, results, views, and conclusions drawn by the authors and it is the sole responsibility of the authors for any legal ramification for the contents in the research papers.

Editorial Board

FROM THE CONVENER'S DESK : REPORT OF THE SEMINAR SERIES

It is a matter of immense pleasure and pride to elucidate the **Foreword** of this Year-Long Seminar Series on **"Women Empowerment and Higher Learning: Revisiting the Perspectives of Sister Nivedita in this e-Era"**. The event was specially organized to commemorate the 150th Birth Anniversary of Sister Nivedita, to whom this college is dedicated. The Lecture series emerged as a major State Level Colloquium with commendable participation from neighbouring colleges as well.

The cardinal theme of this mega-academic event, as entailed before, is well-garnered to portray and resurrect, from oblivion, the lost canvas of Nivedita's thoughts and preaching in this digital age marked by growing intolerance and discontent.

Under the blanket of the cardinal theme, the entire spectrum of events was orchestrated into five seminar-meets, each clustered around topics of related interests :

Seminar 1 – organized by Geology, Geography and Economics departments on the sub-theme "Sister Nivedita : A Contemporary Synergism of Inclusivity, Women Empowerment and Environment-Compliant Society" ; and this marked the Inauguration to the Seminar Series.

Seminar 2 – organized by Physics, Chemistry, Mathematics, Statistics and Computer Science departments on the sub-theme "Vivid Facets of Higher Learning towards Conservation of Life".

Seminar 3 – organized by Bengali, English, Philosophy, Political Science and Sanskrit departments on the sub-theme "Women's Empowerment and Higher Learning".

Seminar 4 – organized by Botany, Zoology, Physiology, Microbiology, Food & Nutrition on the sub-theme "Bio-Revolution and Progressive Life".

Seminar 5 – organized by the college as a whole on the sub-theme "Sister Nivedita: A Symbol of Women Empowerment", followed by a befitting valedictory ceremony.

It is indeed heartening to note and applaud the cumulative efforts and synergism exhibited by all teachers, pupils and staff members of this college to host and conduct a sequel of thought-provoking lecture sessions in quick successions. The organizers have been particularly instrumental to uphold and sensitize the legacy of Sister Nivedita at this crucial juncture of cyber age. Truly, Sister Nivedita sacrificed her whole life as a guardian-angel of hope, enlightenment and support for the women community of colonial Bengal. She had been the pace setter of innovation

and baptized the spirits of inspiration, education and conviction amongst the younger minds of Bengal.

The State colloquium witnessed exudation of some brilliant deliberations by maestros in different disciplines of science, education, art and culture. The powerful oratories made by these distinguished luminaries on techno-scientific and socio-environmental issues scaled the academic ambience to a seminal trance, and kept the learned listeners spell bound. I take this opportunity to express my indebtedness to each one of them.

It is indeed worth to mention here that this entire seminar proceeding was funded by the Department of Higher Education, Government of West Bengal. With this benevolent fund, the colloquium has been overtly successful to resuscitate and comprehend the magnitude and relevance of Nivedita's teachings in this digital era.

I take this golden opportunity to thank all the invited speakers, members of the editorial board and organizing teams, teaching and non-teaching staff members, authors, sponsor, student-volunteers, participants, logistic and maintenance staff, and all others who have contributed in successful arrangement and completion of the year-long conference.

I hope this seminar series has certainly proved out to be the fountain-head of knowledge in all shades and dimensions, and destined to leave behind a rich harvest and treasure trove of academic excellence and poignant memories.

Dr. Saradindra Chakrabarti
Associate Professor, Department of Geology
Convener of the Seminar Series

SCHEDULE OF THE SEMINAR SERIES

As a part of year-long celebration of 150th Birth Anniversary of Sister Nivedita, five Inter-Disciplinary State Level Seminars were organized by different departments of the college and were sponsored by Department of Higher Education, Government of West Bengal. Revolving around the central theme, 'Sister Nivedita, Higher Learning and Women's Empowerment', each seminar was carried out with poster session. Dates, themes, invited speakers and involved departments are as follows:

Seminar Series	Date	Theme	Invited Speakers	Organising Departments
Seminar 1	28th September, 2016	Sister Nivedita : A Contemporary Synergism of Inclusivity, Women Empowerment and Environment-Compliant Society	Prof. Dilip Sinha and Prof. Arunabha Majumder	Geology, Geography, Economics
Seminar 2	29th November, 2016	Vivid Facets of Higher Learning Towards Conservation of Life	Prof. Sabyasachi Sarkar and Dr. Mallar Ray	Physics, Chemistry, Mathematics, Computer Science, Statistics
Seminar 3	6th December, 2016	Women's Empowerment and Higher Learning	Smt. Jaya Chowdhury and Dr. Sampa Sen	Bengali, English, Philosophy, Political Science, Sanskrit
Seminar 4	15th December, 2016	Bio-Revolution and Progressive Life	Prof. Goutam Paul, Prof. Syamal Chakraborti and Prof. Subir Dasgupta	Botany, Zoology, Physiology, Food and Nutrition, Microbiology
Seminar 5	21st February, 2017	Sister Nivedita : A Symbol of Women Empowerment	Dr. Ratnabali Banerjee and Prof. Asoke Chandra Ghose	Sister Nibedita Govt. General Degree College For Girls (Centrally)

CONTENTS

ভগিনী নিবেদিতা অনুধাবনের মাত্রা সন্ধানে

দিলীপ কুমার সিংহ
ভূতপূর্ব উপাচার্য, বিশ্বভারতী বিশ্ববিদ্যালয়, শান্তিনিকেতন

ভগিনী (সিষ্টার) নিবেদিতার বিশেষ মাপের জন্মোৎসবে তাঁর সম্পর্কে আলোচনা বৃদ্ধি পেয়েছে। আংশিকভাবে সমৃদ্ধি পেয়েছে। খোলাখুলি উপস্থাপনা কতখানি হয়েছে, তা বলা শক্ত। সেদিকের ইতিহাস অবশ্যই আছে। পূর্ণবিবৃতি একটু স্বতন্ত্র আকারে পরিবেশিত হয়েছে। তবে তা ঐতিহাসিকতায় একটি আকর্ষণীয় জায়গা করে নিয়েছে। ভগিনী নিবেদিতার, তাঁর সময়ে, ভাবমূর্তির অবস্থানের অনেক কিছুই অনালোচিত রয়ে গেছে। তাঁর সম্পর্কে অনুধাবনের সারি, স্বাভাবিকভাবে, এখনও থমকে না গেলেও, কোনোভাবে সংশয়াতীত হয়নি। পরিপ্রেক্ষিত, অবশ্যই ইতিহাসের দাবী করবে; সম্যকতা, যার অসম্পূর্ণতা তাঁর সময়েই, স্থলাবিঘ্ননের শিকার হয়েছিল। এই রচনার উদ্দেশ্য হল সামগ্রিকতার আধারে কিছু দিকের আলোকপাত করা যাতে তাঁর সম্বন্ধে কতিপয় আহরণ, অন্তত শিক্ষাচত্বরে, উৎকর্ষতা অর্জন করে।

মার্গারেট নোবেলের মত আইরিশ মহিলা এদেশে আসেননি, তা নয়। আইরিশ বিরোধিতাশৈলী ভারতবাসীকে প্রভাবিত করেছে শাসকবর্গের বিরুদ্ধে আন্দোলনে। প্রাক্-স্বাধীনতা পর্যায়ে বিরোধিতার চেহারা যে অন্য বাঁকের, সে সম্পর্কে অত্যুক্তির কোন অবকাশ নেই। সেদিকের মাত্রাসমূহ যে বিভিন্ন নেতৃত্বে ভারতীয়ত্বকে ক্ষুণ্ণ করেনি, তাও অজানা পর্যায়ে পড়ে না। যুগপৎ সরজমিনের দিকে নজর রাখা ও সমব্যথী হিসেবে নয়, সতীক্ষ্ণতার উদাহরণ বেশ কিছু থাকলেও, নির্যাস-সম্মত কতগুলি, তা আন্দাজে আসবে না। সহমর্মী হিসেবে যারা বিদেশে থেকে এসেছেন তারাও যে সন্দিগ্ধতায় পড়েননি তাও বলা যাবে না। অপরদিকে, ভারতে এসে 'করে যাও' লুণ্ঠনে কুণ্ঠা দেখিও না, তথাকথিত 'উৎপাদনে ব্যস্ত থাকো' ক্লাইভ-হেস্টিংসের মদতকারী ভারতীয়দের কথা মেকলের রচনায় বাদ পড়ে নি। সেদিকের হেলানো কেমন যেন মনে হচ্ছে মাথা চাড়া দিচ্ছে, শ্লোগান মাধ্যমে বর্তমানের জিগিরে। এসবের প্রেক্ষাপটে ভগিনী নিবেদিতার অবতারণা কোন স্তরে চলেছে, তা আলোচনার খোরাক জোগাবেই; অথচ সম্পূর্ণ নিরপেক্ষতায় ভগিনী নিবেদিতার বিবর্তনীয় ভাবমূর্তির উপস্থাপনা প্রয়োজনীয় হয়ে দাঁড়িয়েছে। অতীতের, তাঁর সম্পর্কে বিবরণমুখরতা, সাময়িকভাবে উল্লসিত করতে পারে স্থান বিশেষে, তবে ভগিনী নিবেদিতা (ও মার্গারেট নোবেল) সম্পর্কীয় আবেষ্টনীর একটা বিশালত্ব তো আছেই। আলোচনার সুবিধার্থে, প্রথমেই শিক্ষা সম্বন্ধীয় উপাদানে প্রবৃত্ত হওয়া যাক্।

শিক্ষা সম্পর্কে কোনো সংজ্ঞা বা সংজ্ঞার্থের প্রয়োজন নেই। তবে শিক্ষা কিভাবে গ্রহণীয় ও অনুভূত হয়ে থাকে, সেদিকের স্বপদিশা হতেই পারে। সাক্ষরতা অর্জন ও বিধিবদ্ধ শিক্ষাক্রমের অংশীদার হওয়া, প্রতিষ্ঠা পাওয়া ইত্যাদি তো আছেই, রাতারাতি শিক্ষাব্রতী হয়ে যাওয়া তো আছেই; কুর্সিতে বসার সুযোগে।

ISBN : 978-81-933395-0-3

সত্যিতো বিধিবদ্ধতা, শিক্ষার মামুলীতাকে প্রশ্রয় দিয়েছে। আবার ধাক্কা হিসাবে বিভিন্ন দিকের অগ্রণী করেছে। বিধিবদ্ধ-ছুট হয়েছে পড়াশুনার নিবৃত্তি না ঘটিয়ে; সেদিকের উদাহরণ অজস্র। তবে কি ঘরানার প্রভাবমুক্ত হওয়া যায়? তা বোধ করি নয়। কারণ, সেদিকের শিক্ষা, শিক্ষার্থী ও শিক্ষক — এই ত্রয়ীর সংযুক্তি থেকে পলাতক হওয়া যায় না। ব্যবস্থার নিরিখে যাই প্রথা হোক না কেন, আবদ্ধতার কারাগারে বন্দী না হয়ে, অভিনবত্ব হাতছানি দিয়েই থাকে। বাগবাজার চত্বরে ভগিনী নিবেদিতার কর্মযজ্ঞ এক উল্লেখ্য পর্যায়ে এসে গেছে। প্রত্যয়নিষ্ঠা ও কর্মনিষ্ঠা যে যৌথতার বন্ধনে প্রসারিত হতে পারে, তার নমুনা বিরলতার জায়গায় চলে যাচ্ছে। নৈপুণ্যের নামে বাজিমাত না করে, সে আঙিনা যে এক বিশিষ্ট কর্মশৈলীর আহরণে জোগান দেবে, তা কি কারুর প্রশাসনিক প্রত্যাশায় পড়ত?

ভগিনী নিবেদিতার পরিচিতি, মুখ্যতঃ যে রামকৃষ্ণ-বিবেকানন্দের ঘরানার, তা কারুর অজানা নয়। স্বামীজী ও মার্গারেট নোবেলের যে প্রথম আর্ন্তসংযোজকতা, এক বক্তৃতার মাধ্যমে, তা কোনোভাবেই উদ্যোক্তা মার্গারেট নোবেলের মুগ্ধতার মাত্রায় পড়েনি। ভারত ও স্বামীজী সম্পর্কে স্বল্প পরিচিতি ইতস্ততার কারণ হয়ে দাঁড়ালেও, সুপ্ত প্রতিবাদ বা ভিন্নমত পোষণ, বিশেষতঃ আয়ারল্যাণ্ডবাসী হয়ে এক উন্মুক্ততার অপেক্ষায় ছিল। বিবেকানন্দের প্রত্যুত্তর নয়, এক বড় সাড়া, মার্গারেট নোবেল ও পরবর্তীকালে ভগিনী নিবেদিতার মানসিকতায় জায়গা করে নিয়েছিল। ভগিনীর দিক থেকে নয়া দাবিতে ভারতকে আবিষ্কার করতে এবং ঔৎকর্ষের পথে নিয়ে যেতে তাঁকে ব্রতী করতে পেরেছিল। উভয়ের পক্ষে কোনো পদক্ষেপ স্বাস্থ্যকরভাবে সংশয়বিহীন হয় নি। স্কটিশ কলেজের মাস্টার মহাশয় থেকে রামকৃষ্ণ পরমহংসর সান্নিধ্যে প্রশ্নবাহী হয়ে, এক ঘরানার নেতৃত্ব দিলেন স্বামী বিবেকানন্দ। শিক্ষা দুনিয়ার এক বৃহত্তর দিকের আগাম-ভাবনা না থাকলে, ঠাকুর সম্পর্কে 'আমার মাষ্টার' রচনা করা বাস্তবায়িত হোত না স্বামী বিবেকানন্দের। এটা কোন এক খপ্পরে পড়া নয়। দিনের পর দিন সূক্ষ্মতার বিচারে প্রবৃত্ত হওয়াতে স্বামীজী দেখলেন এক শিক্ষক ও শিক্ষা-গ্রহীতার এক অপূর্ব শৈলী। শ্রেণীকক্ষের অন্য চেহারা মিলেছিল। বলতে গেলে, এও একটা অনুধাবনের রূপান্তর — ব্যক্তিত্ব, সময় ও স্থান বিশেষে। 'মাষ্টার' শব্দের উৎপত্তি হল নিঃসংশয়ে দক্ষিণেশ্বর চত্বরে মহেন্দ্র লাল গুপ্তের আগমনের পর থেকে। পরমহংসদেবের সান্নিধ্যের অভাবনীয় পরিবর্তন, নানা দিকে, নানা লোকের ঘোরাফেরা, আলাপচারিতা — সব কিছুই শিক্ষণীয় হয়ে দাঁড়াল। সেদিকের ভাষ্যায়ন প্রভূতভাবেই হয়েছিল, উদ্‌গ্রীবতার কারণে। কিন্তু ভগিনী নিবেদিতার দিক থেকে দৃষ্টিভঙ্গীর স্বাতন্ত্র্য, পারিবারিকতায় সম্পৃক্ত হলেও নজর কাড়বেই। নিবেদিতার রচনাবলী কিছু ইঙ্গিত কি দিতে পারে? দেখা যাক্।

ভগিনী নিবেদিতার প্রত্যেক রচনা এক জ্ঞানান্বেষণ তো বটেই। আধ্যাত্মিকতার ভূমিশিলা তো স্থায়ীভাবে প্রতিষ্ঠিত হয়ে গেছে। তাও কোনোভাবে, মামুলীত্বের গহ্বরে পতিত না হয়ে, ভারতীয়ত্বের ভিন্নতর চেহারা তা উন্মোচন করে। আধ্যাত্মিকতা যেন কোনোভাবেই বিঘ্নিত না হয়; তত্ত্বজ্ঞানের উৎসও যেন নির্বাপিত না হয়।

স্বাদেশিক আন্দোলন ওঁর দিক থেকে মদত পেয়েছে। আপাতবাহ্য হলেও, খুঁজে বেড়িয়েছেন ব্যক্তিত্বদের যাঁদের বিপ্লবাত্মক আত্মিকতায় সংহতি মিলেছে। প্রশাসনিক তৎপরতা তাঁকে উৎখাতে সমর্থ না হলেও, তাঁকে ব্যথিত করেছে সদ্যপ্রতিষ্ঠিত ঘরানার নৈকট্য থেকে সরিয়ে রাখা। তাই ভারত সন্ধানে উনি উদ্বাস্তু হয়ে গেলেন। যে 'মাষ্টার'কে উনি জানতেন, তার তিরোধান পর্যন্ত, সেদিকের কোনোরকম হেরফের হয়নি। তীক্ষ্ণ নজর কিন্তু এড়াতে পারেনি; অভিযোগসমূহ যে আপেক্ষিকতায় দুর্বল, অভিযুক্তদের অধ্যাত্মবাদে পুষ্ট বিপ্লবের প্রেক্ষাপটে, তা পরবর্তীকালে সমঝে নিয়েছে। অনিবার্যভাবে খুঁজতে হল নিবেদিতাকে, আত্ম-সন্ধানের স্বার্থে, আখড়া নয়, এক শরণাপন্ন আশ্রয়ে। ঘরানার বিস্তৃতি দেখা গেল, অর্থাৎ হল 'রামকৃষ্ণ-বিবেকানন্দ-সারদা ঘরানা'। মা সারদার সঙ্গে যত চিত্রলিপি দেখা যায়, তা নিশ্চিতভাবে দেখায় নৈকট্যের অনন্যতা। মা সারদার কক্ষের দ্বারে দণ্ডায়মান নিবেদিতাকে দেখিয়েছে অনুপ্রবেশের আকুতি; একই খাটে উপবিষ্ট মা সারদা ও ভগিনী নিবেদিতার সংলাপের ব্যস্ততা, পারস্পরিক আবদ্ধ দেখাদেখি। এসবই কি পথরেখা খোঁজার চিত্রলিপি

নয়, যা দেখিয়েছে ভারত সন্ধানের এক দশা ? ভারত-আবিষ্কার এক চিরন্তনী প্রয়াস। সেদিকে সক্রিয় না হলে ভারতীয় ঔৎকর্ষ নিরূপণ সম্ভব হবে না। স্থূলতায় ভারত কাহিনীর বিবরণ নয়, ভারত সম্পর্কে রচনাসম্ভার যা বেশীরভাগ অভিজ্ঞতা ও ভাষণ প্রসূত এক বিশিষ্ট শিরোনামে প্রকাশিত হয়েছিল। আক্ষরিক তর্জমা করলে দাঁড়ায়, ভারতীয় জীবনের বুনট (web)। কিঞ্চিৎ সম্প্রসারণে তা ভারতীয় জীবনের বুননের ইঙ্গিত দেওয়ার কথা। 'জীবন' শব্দটির ব্যবহারে গুণগত মাত্রার কথা এসেই যাবে। বস্তুতঃ এখনকার অনুরূপ ভাবনার, আগাম-বার্তা নিবেদিতা পেশ করতে পেরেছিলেন। প্রত্যেক প্রবন্ধের শিরোনামেও সারবত্তায় মালুম পাওয়া যায়, এক প্রত্যক্ষ/পরোক্ষ উত্তরভাগ, যার সিংহভাগ আধুনিক ভাবনায় পড়ে। 'হিন্দু'/'ইসলাম' শব্দের উল্লেখে কোনো সংকীর্ণতাকে প্রশ্রয় দেননি। বরঞ্চ বিপরীতে, ভারতীয় বৈচিত্র্যের অবহিতি দিয়েছে। 'হিন্দু কলেজ' বললেই প্রতিবাদীত্বের যেমন হদিস মিলে যাবে, বোধ করি একই অনুরণনে নিবেদিতার ভাবনা-বুনন অসাধারণভাবে গঠিত হয়েছে। আপাতভাবে, প্রাথমিক অবতারণা এবড়ো-খেবড়োর গাড্ডায় পড়লেও, দেখিয়েছে ভারতীয় কৃষ্টির এক পর্যাপ্ত সংহতি; কিছুটা উদাহরণে যেমন পূর্বাঞ্চলের আবাসনে, বিশেষ করে সে চত্বরে গৃহিনীদের সম্পর্কে বক্তব্য, খোলাখুলিভাবে এবং সতীক্ষ্ণতায়। আর এক আনুষংগিক সংকলনে ঠাঁই পেয়েছে আত্মিকতায় প্রব্রাজিকা হওয়া। বেশ কিছুতে বাসিন্দা হয়ে, পরিচিতির আত্মিকরণে সামিল হওয়া যে পরবর্তী অনুধাবনের সহায়ক হবে, সেদিকে এক সাহসী ভূমিকা গ্রহণ করেছিলেন ভগিনী নিবেদিতা।

উপরোক্ত দুটি রচনা সংকলনের মধ্যে বড় অংশ জুড়ে আছে মহিলাদের সম্পর্কে, বিশেষ করে মাতৃত্বের চর্চায়, সহধর্মিনী হিসেবে, জাতীয় পর্যায়ে নারী জাতির অবস্থান এবং হিন্দু বিধবা ও জেনানা, সম্পর্কে। উৎসবের, বিশেষ করে পূর্বাঞ্চলের ও গ্রামাঞ্চলের সোৎসুক আলোচনা, এসব সংকলনে আছে। 'ভারতের মধ্যযুগীয় বিশ্ববিদ্যালয়' শীর্ষনামে প্রবন্ধটি নালন্দা বিশ্ববিদ্যালয় সম্পর্কিত হাল্‌ফিল গুমরানোয় স্পন্দন জোগাতে পারে। সত্যি কথা বলতে কি, সীমিতভাবে নয়, শিক্ষায় অবাঞ্ছিত প্রতিষ্ঠানিকতার প্রেক্ষাপটে।

ভারত-আগমনের প্রাক্কালে নিবেদিতা জানা 'মাষ্টার' স্বামী বিবেকানন্দের নির্দেশ/উপদেশ, মার্গারেট নোবেলের পরিচিত অধ্যায়, এক ব্যাপ্তির ও গুণগতভাবে সত্তা অর্জনের সামর্থ্য, দেখিয়েছে। প্রাসঙ্গিক আন্তর্জাতিকতা কেবলমাত্র দেশ/অঞ্চলের সমষ্টিতে মেলে না বীজগাণিতিকতায় ওঠা/বসা (ইতিবাচক/নেতিবাচক)'র যোগফল দ্বারা নির্ণীত হতেই পারে। আর্ন্তজাতিকতায় গড়-পড়তা আরোপ অর্জন করতে হলে, বাছাই পর্ব এসে যাবেই। অনুমেয় পর্যায়ে এসে যাবে শীর্ষদিকসমূহের অবহিতি যা সাধারণীকরণে সহায়তা জোগাবে। উজ্জ্বল অথচ স্বতন্ত্র দৃষ্টিকোণ থেকে একীকরণে সমর্থ হতে হলে, দরকার এক সংস্কৃতি সম্পৃক্ত কুশলতা। আরও বিভিন্ন প্রান্তে ছড়িয়ে/চারিয়ে দেবার ক্ষমতা অর্জনের নেতৃত্বকে বলীয়ান হতেই হবে। প্রাক্-গতিশীলতার উপকরণকে চিহ্নিত করা প্রয়োজনীয় তো হবেই। স্তর-বিশেষে কি অনুদান মিলতে পারে, সেদিকের দৃষ্টি যেন ক্ষীয়মান না হয়। এদিকের পথরেখা জীবনের গুণগত অঙ্গনে চলেই যাবে। উন্নয়নী অনুশীলনে যে বৃত্তরেখা প্রায় অবধারিতভাবে সম্প্রসারিত হচ্ছে, অবশ্য সাংস্কৃতিক পুঁজি সাপেক্ষে, জীবন শৈলীর অনুধাবন নিত্যনৈমিত্তিকতার আওতায় এসে যাচ্ছেই। সেদিকের বর্হিভুক্তির কোন অবকাশ নেই। অধুনা সে সব প্রান্তের পথ-প্রদর্শিকা হচ্ছেন, মার্থা মি নানবাউস। মার্থা দেবীর রচনাবলীর এক লব্ধ প্রতিষ্ঠ সংযোজক হলেন অমর্ত্য সেন। উভয়েই, এক বিশেষ সংকলনে গুণসমৃদ্ধ জীবনের সামগ্রিকতায় মহিলাদের অবস্থান সম্পর্কে আলোচনা যোগ করেছেন। গভীর আলোচনায় স্থান পেয়েছে মাত্রাগত ফারাক আছে কি না বা আদৌ নির্ণয়ে পড়ছে কি না। লিঙ্গ সম্পর্কিত সামাজিক বিচার সালতামামিতে নয়, বিশেষতঃ মহিলা সম্পর্কে, আলোচিত হয়েছে নয়া দৃষ্টিকোণে। প্রায় সম-অনুরণনে বলা যেতে পারে, ভগিনী নিবেদিতার দৃষ্টিভঙ্গীর বিশেষ দিক ছিল জীবন ও সংস্কৃতির যৌথতার পটভূমিকায়। প্রথাগতভাবে দীক্ষিত না হলেও অধ্যাত্মবাদে যে পরিপুষ্ট হওয়া যায় বৈপ্লবিকতার সমৃদ্ধিতে, অর্থাৎ পারস্পরিকতা বিরাজ করতে পারে সে সব আঙিনায়, সেদিকে নিবেদিতার দৃঢ়তাকে উপেক্ষা করতে দেখা যায় নি।

উপসংহারে বলা যায়, আশ্রম-অন্বেষণে নিবেদিতাকে নিরুপায় হতে দেখা যায়নি, বিলেত থেকে স্বামীজির তিরোধানের পর বা কিছু পূর্বে যে মা সারদা এবং আমৃত্যু বসু পরিবারের সান্নিধ্যে দেখিয়েছেন, তা এক স্তম্ভ থেকে আরেক স্তম্ভে শরণার্থী হওয়া নয়, ওঁর প্রতিবাদীত্বের অক্ষুন্নতা। রবীন্দ্রনাথ ঠাকুর, রামানন্দ চট্টোপাধ্যায়, অরবিন্দ ঘোষ প্রমুখেরা নিবেদিতার থেকে দূরত্ব রাখেন নি, মুখ্যতঃ প্রতিবাদীত্ব বনাম অভিনবত্বের বিবর্তনীয়তার নেত্রী হওয়ার নিমিত্তে। আশা করতে দোষ কোথায়, ভগিনী নিবেদিতা জীবিত থাকলে, প্রযুক্তির নানা উদ্ভাবনী প্রযুক্তির মাধ্যমে সাংগঠনিক প্রতিবাদে কুণ্ঠিত হতেন না, বিশেষত শিক্ষার্থীর ও কৃষ্টির স্বার্থে।

150th
Birth Anniversary
Celebration

THE SPIRITUAL JOURNEY FROM MISS MARGARET NOBLE TO SISTER NIVEDITA : DOCUMENTED IN THE LETTERS OF SWAMI VIVEKANANDA

Ratnabali Banerjee
Former Joint Secretary, University Grants Commission

When we were research scholars, the laboratory was our temple. Most of the time was spent there, depositing thin films of different materials and characterizing the films in terms of their structural and optoelectronic properties. There was no scope of looking at the results subjectively. It was objective all the way. In fact, it was that way only, since we left school. How one missed the essays on different topics! So much freedom! The one outlet was the letters we wrote. It depended upon the occasion, the person addressed and obviously, the relationship with the person. Again, the relationship between two individuals could evolve with time. The letters would then certainly reflect that. One can imagine the effect on the reader when reading the letters of one great soul to another!

When the sesquicentenary celebrations of Sister Nivedita are going on, one would naturally think of her Guru, Swami Vivekananda. How did the relationship between the Guru and his disciple evolve, as one understands fro*m Letters of Swami Vivekananda* (henceforth to be referred to as *Letters*)? In *The Master as I saw him*, Sister Nivedita, then Miss Margaret Noble, recorded that the first time she saw him was on the occasion of his visit to England in 1895. It was a Sunday afternoon in November and the place was a drawing room where fifteen or sixteen guests had gathered (Nivedita, Sister 3, 4). However, it was only on 7th June, 1896 that Swami Vivekananda wrote the first letter to her, where he addressed her as Miss Noble (*Letters* 294-295). In that letter, he explained his ideal, which was to preach the divinity of mankind and the way to make it manifest in every movement of life. He saw that the world was in chains of superstition. Misery was caused by *ignorance*. To give the world light, sacrifice was needed by the "earth's bravest and best", sacrifice "for the good of many, for the welfare of all".

Swamiji had understood in those few months that Miss Noble had the making of a world-mover. The very first letter was a call to her. Swamiji wrote:

> It is no superstition with you, I am sure, you have the making in you of a world-mover, and others will also come. Bold words and bolder deeds are what we want. Awake, awake, great ones! The world is burning with misery. Can you sleep? Let us call and call till the sleeping gods awake, till the god within answers to the call.

Swamiji had made it clear that it was not out of any superstition when he claimed "you have the making in you of a world-mover". What an effect it would have had

ISBN : 978-81-933395-0-3

on Margaret Noble! Pravrajika Muktiprana, in her Bengali book, *Bhogini Nibedita*, writes how, after reading the letter, Margaret was left speechless. She was completely overwhelmed (Muktiprana, Pravrajika 40). Swamiji had explained his idea clearly in a few fiery sentences. Her "god within" could not but answer to his call.

On 28th November,1896, Swami Vivekananda wrote to the Hale sisters, Mary and Harriet, informing them that Mr. and Mrs. Sevier as well as Mr. Goodwin, English disciples of Swamiji, would go to India with him to work and spend their own money on it (*Letters* 319). Mary and Harriet were daughters of Mr. and Mrs. George W. Hale. Mrs. Hale had helped him when he had been stranded in Chicago, before the Parliament of Religions (*Letters* 459). However, there was no mention of Miss Noble.

Swamiji wrote to Miss Noble on 5th May, 1897. This was in reply to her "very very kind, loving and encouraging letter", which, as he expressed, gave him more strength than she would have thought of. He was writing from Alambazar Math. The work had been started. We know that on 1st May, 1897, the Ramakrishna Mission Association had come into existence (Muktiprana, Pravrajika 45). Swamiji wrote:

> So far about work. Now about you personally. Such love and faith and devotion like yours, dear Miss Noble, repays a hundred times over any amount of labour one undergoes in this life. May all blessings be yours. My whole life is at your service, as we may say in our mother tongue (*Letters* 333).

To Marie Halboister, one of his English devotees, Swamiji mentioned Miss Noble, in his letter dated 2nd June, 1897 (*Letters* 340). He wrote, " Do you know Miss Noble? Do you ever see her?" On the very next day, he wrote to Miss Noble from Almora (*Letters* 341). The expression was one of contentment. He had been able to rouse a good many people. He had seen life, and it was all for self. Looking back at his own life, he could scarcely find any action he had done for self – even his wicked deeds were not for self. So he was content.

On 23rd July, 1897, he wrote to Miss Noble from Almora (*Letters* 357-358). This is a very important letter, where he expressed that Miss Noble could do more work from England than by coming to India. He further wrote, "Lord bless you for your great self-sacrifice for the poor Indians."

However, after learning from Mr. E.T. Sturdy and Miss Henrietta Muller, English devotees of Swamiji, about Miss Noble's determination to come to India, in the very next letter to Miss Noble, dated 29th July, 1897 (*Letters* 362-364), we find that his views had changed. Swamiji wrote:

> Let me tell you frankly that I am now convinced that you have a great future in the work for India. What was wanted was not a man, but a woman; a real lioness, to work for the Indians, women specially.
>
> India cannot yet produce great women, she must borrow them from other nations. Your education, sincerity, purity, immense love, determination, and above all, the Celtic blood make you just the woman wanted.

It must have hurt Swami Vivekananda to write that India could not yet produce great women. He had earlier approached Sm. Sarala Ghoshal, a niece of Rabindranath Tagore and Editor, *Bharati*. In his letter dated 24th April, 1897 (*Letters* 327-332) he had written:

> In the West, women rule; all influence and power are theirs. If bold and talented women like yourself, versed in Vedanta, go to England to preach, I am sure that

> every year hundreds of men and women will become blessed by adopting the religion of the land of Bharata. ……. Will there be no woman, in the land of Maitreyi, Khana, Lilavati, Savitri, and Ubhayabharati, who will venture to do this?

However, it was not from any Indian woman that Swamiji got a response to his fervent appeal. It was Margaret, a foreigner, who was ready to sacrifice everything for the work (Muktiprana, Pravrajika 45). India had to borrow, as Swamiji had written to Miss Noble.

Yet, he had to apprise Miss Noble about the ground reality. It was going to be difficult. Swamiji wrote:

> You cannot form any idea of the misery, the superstition, and the slavery that are here. You will be in the midst of a mass of half-naked men and women with quaint ideas of caste and isolation, shunning the white skin through fear or hatred and hated by them intensely. On the other hand, you will be looked upon by the white as a crank, and every one of your movements will be watched with suspicion (*Letters* 363).

Swamiji also wrote about the fearfully hot climate and the absence of European comfort in places out of the cities. He was not trying to dissuade her. But he had to ensure that she would not get disillusioned after reaching India. He wrote:

> If, in spite of this, you dare venture into the work, you are welcome, a hundred times welcome. As for me, I am nobody here as elsewhere, but what little influence I have, shall be devoted to your service.

He assured her that he would stand by her *unto death*, even if she failed in the work or got disgusted. Swamiji wanted her to be independent and not be under the wings of Miss Henrietta Muller or anybody else. He wrote:

> Friendship with many is best at a distance, and everything goes well with the person who stands on his own feet.

In the same letter, Swamiji praised Mr. and Mrs. Sevier. They were the *only* English people who did not hate the natives. He informed Miss Noble that two of his friends from America, Mrs. Ole Bull and Miss Josephine MacLeod, were to visit India in the autumn.

He had welcomed Miss Noble. However, he wrote to Mrs. Ole Bull on 19th August, 1897 that there was a young English woman, Miss Margaret Noble, who was very eager to learn the state of things in India, so that she could do some work when she went back home (*Letters* 364-365). From Swamiji's letter it appears that at that point of time the idea was, Miss Noble would come to India to gain first-hand experience and then go back to England to do some work.

On 1st October, 1897, Swami Vivekananda, for the first time in his letter, while addressing Sister Nivedita, changed from the formal Miss Noble to a more personal Margot (*Letters* 366-367). Swamiji knew that Margaret was coming to India depending totally upon him. Not only did she respect him deeply but she also adored him – the great personality that Swami Vivekananda was. But Swamiji had to make her aware, right from the beginning, that the goal of life was to raise oneself from the worship of the person to the non-person (Muktiprana, Pravrajika 52). Therefore, in this letter, where he addressed her in a more informal manner, Swamiji made it clear that while it was absolutely necessary to the work that he had to have the enthusiastic love of as

many as possible, he, as a leader, had to remain impersonal. That did not mean that one had to be a brute, exploiting the devotion of others. He admitted that he was intensely personal in his love, but at the same time had the power to pluck out his heart with his own hand, if it became necessary, "for the good of many, for the welfare of many", quoting Buddha. Swamiji wrote:

> Madness of love, and yet in it no bondage. Matter changed into spirit by the force of love. Nay, that is the gist of our Vedanta. …… The ignorant see the person in the non-person. The sage sees the non-person in the person.

1898 was a very important year in the life of Sister Nivedita. On 28th January, 1898, Margaret Noble landed in India (Nivedita, Sister 55). On 17th March, 1898, she had, for the first time, the *darshan* of the Holy Mother, Shri Sarada Devi. On 25th March, 1898, Margaret was initiated into *brahmacharya* by Swami Vivekananda. Her Guru named her Nivedita, meaning Dedicated (Muktiprana, Pravrajika 67-69).

On 17th March, 1904, Sister Nivedita wrote to Miss Josephine MacLeod, remembering the day, when six years earlier, she had seen the Holy Mother for the first time. She further recorded, it was on that day when Swamiji called her by her name – Margaret (*Letters of Sister Nivedita, Volume Two* 636). However, from *Letters of Swami Vivekananda*, we see that he had already addressed her as Margot in his letter dated 1st October, 1897 (*Letters* 366). To Miss MacLeod, Nivedita further wrote that the next Friday, 25th March, 1904, would be her birthday, when she was first called "Nivedita".

In March, 1898, Swami Vivekananda wrote to Swami Ramakrishnananda (Shashi Maharaj). The date is not mentioned. It must have been before Sister Nivedita's brahmacharya. He wrote:

> Miss Noble is really an acquisition. She will soon surpass Mrs. Besant as a speaker, I am sure (*Letters* 377).

He was referring to Mrs. Annie Besant, the famous theosophist and orator. He also wrote that the European and American ladies went to see the Holy Mother and Mother actually ate with them. That was a great thing in those days. So this letter must have been written after Nivedita's first *darshan* of the Holy Mother on 17th March, 1898 and before her *brahmacharya* on 25th March, 1898.

On 17th July, 1898, Swami Vivekananda, in his letter to Swami Brahmananda (Rakhal Maharaj), wrote, among other issues, that the Nivedita Girls' School in Calcutta had to be put on a firm footing (*Letters* 380-381). *In The Master as I saw him*, Sister Nivedita recorded:

> It had been taken for granted from the first, that at the earliest opportunity I would open a girls' school in Calcutta. And it was characteristic of the Swami's methods, that I had not been hurried in the initiation of this work, but had been given leisure and travel and mental preparation (Nivedita, Sister 136).

The school finally opened on the day of Kali Puja, in 1898. The Holy Mother herself performed the opening ceremony of worship (Nivedita, Sister 153). As recorded by Pravrajika Muktiprana, the Holy Mother came with Golap Ma and Jogin Ma. Swamiji, Swami Brahmananda and Swami Saradananda participated in the ceremony (Muktiprana, Pravrajika 124).

On 20th June, 1899, Swami Vivekananda sailed for the West with his Gurubhai, Swami Turiyananda and Sister Nivedita (Nivedita, Sister 169). It was from Ridgely Manor, New York, that Swamiji wrote to his disciple "Margot" on 1st November, 1899.

He felt that there was a gloom over her mind. He consoled her – life was not eternal and nothing was to last forever. He also wrote that suffering was the lot of the world's best and bravest. He was glad that he was, amongst others, one of nature's sacrifices (*Letters* 398).

It is not understood why there was a gloom over Nivedita's mind. She was staying in a cottage near the place where Swamiji was staying. She was writing the book *Kali the Mother* at that time (Muktiprana, Pravrajika 161). On 5th November, Swamiji left Ridgely Manor and on the 7th, Nivedita also left for Chicago (Muktiprana, Pravrajika 162).

On 6th December, 1899, Swami Vivekananda wrote to "Margot" from Los Angeles (*Letters* 404). He was in a contemplative mood. He knew that some people loved to be miserable. He was sure that if he did not break his heart over people he was born amongst, he would do it for somebody else. A very important thought was expressed in the letter. Swamiji wrote:

> If you are really ready to take the world's burden, take it by all means. But do not let us hear your groans and curses. . . . .
>
> The man who really takes the burden blesses the world and goes his own way..…….. . It is the Saviour who should "go his way rejoicing, and not the saved". ……..
>
> Come ye that are heavily laden and lay all your burden on me, and then do whatever you like and be happy and forget that I ever existed.

Swamiji explained in his letter that the man who took the burden on his shoulders willingly, voluntarily, would not have a word of condemnation or criticism in spite of the presence of evil (*Letters* 404). What profound thoughts! We must also remember to whom it was addressed.

On 24th January, 1900, Swamiji again wrote to "Margot". He had wanted "rest and peace". But Mother had willed otherwise (*Letters* 408-409). He wrote:

> But Mother does good to others through me, at least some to my native land, and it is easier to be reconciled to one's fate as a sacrifice. We are all sacrifices – each in his own way. The great worship is going on – no one can see its meaning except that it is a great sacrifice.

He was willing to be an instrument of Mother in the great sacrifice. He was determined not to resist but be a willing one.

Yet, he did want to have a quiet time. He did not want to work. He needed rest. In his letter to Nivedita dated 4th March, 1900, from San Francisco (*Letters* 413), we get such an expression from him. Yet he was driven by Fate or Karma. Fear was at the root of misery, of disease, etc., he wrote. By being afraid of hurting, one hurt and injured others all the more. Swamiji wrote:

> Oh, to become fearless, to be daring, to be careless of everything! . . .

On 22nd March, 1900, Swami Vivekananda wrote to Miss Mary Hale from San Francisco (*Letters* 415). It was in reply to a note from her. There are some sensitive lines in this letter. He had many other thoughts to think besides Indian people. But everything had to go to the background before his Master's work. Swamiji wrote:

> I would that this sacrifice were pleasant. It is not, and naturally makes one bitter at times; for know, Mary, I am yet a man and cannot wholly forget myself; hope I shall some time. Pray for me.

> Of course I am not to be held responsible for Miss MacLeod's or Miss Noble's or anybody else's views regarding myself or anything else, am I? You never found me smart under criticism.

Pravrajika Muktiprana has recorded that sometime prior to this, Nivedita had a painful experience with Mary Hale. She had wanted Mary Hale's active support in her work at Chicago. Mary Hale not only refused but also made it clear that in future, she or her family would not maintain any connection with her (Muktiprana, Pravrajika 174).

On 25th March, 1900, Swamiji wrote to Nivedita from San Francisco (*Letters* 416). He wrote that he was much better and growing very strong. The torture of the last two years had taught him that disease and misfortune came to do good in the long run. He wrote:

> I am the infinite blue sky; the clouds may gather over me, but I am the same infinite blue.

He was trying to get a taste of that peace which he knew was his and everyone's nature. Bodies, he called tin-pots. Dreams of happiness and misery were foolish – his dreams were breaking.

After untiring efforts, Nivedita did manage to get some support. On 28th March, 1900, Swamiji wrote to "Margot" expressing his happiness at her good fortune. He was sure that she would get all the money she required for her work – she would get it in America or in England (*Letters* 418-419). Swamiji also wrote that his ill health had made him understand what non-attachment meant. He hoped to be perfectly non-attached very soon.

Swamiji mentioned that he had enjoyed her account of Prof. Geddes. He meant Professor Patrick Geddes, the eminent sociologist. Marie Louise Burke, in *Swami Vivekananda His Second Visit to the West New Discoveries*, records that it was in March (1900) that Nivedita met Patrick Geddes and "she sat down with avidity to the intellectual feast Professor Geddes spread before her". She was dazzled and on 13th March, 1900, her feelings found expression in her letter to Swamiji, where she wrote to him at length about her new friend (Burke, Marie Louise 635-637). It was in reply to this letter that Swamiji wrote that he had enjoyed her account of Prof. Geddes.

According to Marie Louise Burke, Sister Nivedita was fascinated by many of the theories of Prof. Geddes. She committed herself to working for him, as his secretary. Prof. Geddes was to organize various sessions at the International Exposition of 1900 in Paris and she arranged to meet him in Paris in early July (Burke, Marie Louise 637).

It seems, Sister Nivedita's moods were fluctuating at that time. After being fascinated by Prof. Geddes, she again became despondent. Her Guru wrote on 26th May, 1900:

> Don't despond in the least. *Shri wah Guru! Shri wah Guru!* You come of the blood of a Kshatriya. Our yellow garb is the robe of death on the field of battle. Death for the cause is our goal, not success. *Shri wah Guru!* . . .

Swamiji ended with the line:

> Steady, child, don't be bought by gold or anything else, and we win!

A father was writing to his spiritual daughter, consoling her, guiding her, guarding her, telling her to be steady (*Letters* 425-426).

His next letter was from Paris. It was almost three months after the fatherly advice he had given to Nivedita in his letter from San Francisco dated 26th May, 1900. In the letter from Paris, written on 25th August, 1900, Swamiji informed Nivedita that he

had resigned the Presidentship of the Ramakrishna Mission. He had retired for good and would devote the rest of his life to himself. He further wrote that he no longer represented anybody. He had given his best energies, unto death almost, and received only "hectoring and mischief-making and botheration". He was done with everyone in India and also abroad (*Letters* 431-432).

It is the next part of the letter, responding particularly to a letter from Sister Nivedita, which makes one sit up. Swamiji wrote:

> Your letter indicates that I am jealous of your new friends. You must know once for all I am born without jealousy, without avarice, without the desire to rule – whatever other vices I am born with.
>
> I never directed you before; now, after I am nobody in the work, I have no direction whatever. I only know this much: So long as you serve "Mother" with a whole heart, She will be your guide.
>
> I never had any jealousy about what friends you made. I never criticised my brethren for mixing up in anything. Only I do believe the Western people have the peculiarity of trying to force upon others whatever seems good to them, forgetting that what is good for you may not be good for others. As such, I am afraid you might try to force upon others whatever turn your mind might take in contact with new friends. That was the only reason I sometimes tried to stop any particular influence and nothing else.
>
> You are free, have your own choice, your own work. . . . *(Letters* 432).

In what context did Swami Vivekananda write such a firm letter? What had Nivedita written? She was clearly distressed. Marie Louise Burke had not seen the letter herself (Burke, Marie Louise 690). Pravrajika Muktiprana, in her book, *Bhogini Nibedita*, has also not given a translation in Bengali of the said letter. She has only mentioned that although Nivedita used to meet Swamiji frequently at that time, she could not speak about her feelings and finally resorted to writing a letter, to which Swamiji replied (Muktiprana, Pravrajika 187). The translation of Swamiji's letter is there (Muktiprana, Pravrajika 187-188), but not that of the letter written by Sister Nivedita.

There was a certain coolness, indifference on Swamiji's part. Burke reports that in her letter, Nivedita had complained and at the same time she had sought his guidance. She was at that time involved with Prof. Geddes's work. Swamiji would have seen that her mind was moving away from the work he had given her and had trained her for. He must have been disappointed and at once gave her the freedom to work in her own way (Burke, Marie Louise 690). He became aloof.

There are many indications in *Letters of Swami Vivekananda* that at that time he was in a general mood of withdrawal. However, Burke's interpretation is that there would have been a vast difference in expression between Swamiji's general mood of withdrawal and his personal coolness. A person as perceptive as Nivedita could not have failed to detect that (Burke, Marie Louise 688).

Pravrajika Muktiprana has attributed her distress to her apprehension that Swamiji did not approve of her connection with the Brahmo Samaj. Over exposure to the ideas of the Brahmo Samaj could be detrimental to Nivedita's acceptance of the Hindu ideology and understanding of India. With this in mind, Swamiji had wanted to keep her away from frequenting the Brahmo Samaj and interacting with its members (Muktiprana, Pravrajika 187). Even at the time when there had been discussion about the school

which Nivedita was to start and she had spoken about some women from the Brahmo Samaj, who were willing to help her, Swamiji had been firm that they should not be included in the project (Muktiprana, Pravrajika 121).

Coming back to Swami Vivekananda's letter, it did nothing to assuage her suffering. Burke reports that his letter to Nivedita dated 28th August, 1900, turned out to have been written to Sister Christine, disciple of Swami Vivekananda (Burke, Marie Louise 692). It was left to Mrs. Ole Bull and Miss Josephine MacLeod to invite Swami Vivekananda to Brittany where Swamiji's "deep, unalterable affection for his disciple, her own unhappiness over what she felt to be his indifference, and her emotional recommitment to his work" brought about a kind of reconciliation between the father and his spiritual daughter (Burke, Marie Louise 699).

On 6th January, 1901, Swamiji wrote to Mrs. Ole Bull from Mayavati:

> I am very glad to learn that Margot is leaving her lore for future use. Her book has been very much appreciated here, but the publishers do not seem to make any effort at sale (*Letters* 448).

He was referring to *Kali the Mother*. This was the book which, as mentioned earlier, Sister Nivedita had been working on at Ridgely Manor.

On 27th August, 1901, Swamiji wrote to Miss Mary Hale:

> I have not had any direct message from Mrs. Bull or Nivedita, but I hear regularly from Mrs. Sevier, and they are all in Norway as guests of Mrs. Bull. I don't know when Nivedita comes to India or if she ever comes back (*Letters* 450). Again, his deep affection for Sister Nivedita is apparent from these lines.

On 7th September, 1901, he wrote to Nivedita from Belur Math (*Letters* 451). It contained sundry news from the Math – about the rain, his huge stork, his tame antelope, geese, and so forth. Only in the opening lines he expressed how he tried to keep down the spring while working for the cause. But something or other would happen, the spring would go whirr and one was back to work – thinking, remembering, scribbling, scrawling (*Letters* 451).

Sister Nivedita and Mrs. Ole Bull reached Madras on 3rd February, 1902. Sister Nivedita was felicitated in Madras and she also addressed the gathering on that occasion. She was back to her familiar Bosepara Lane on 9th February, 1902 (Muktiprana, Pravrajika 211). Swamiji was in Varanasi and wrote to Mrs. Ole Bull and Sister Nivedita on 10th February, 1902:

> Welcome to India once more, dear Mother and daughter.

He had earlier expressed his doubts to Miss Mary Hale (*Letters* 450) about Nivedita's plans of returning to India. He was therefore happy that Nivedita had returned and delighted with the reception given to her in Madras.

Swamiji had such plans for Sister Nivedita's school! He wanted them to visit a few villages west of Calcutta to see the old Bengali structures made of bamboo, cane, mica and grass. He wished he could build the whole of Nivedita's school in that style (*Letters* 453).

On 12th February, 1902, Swamiji wrote to Sister Nivedita:

> May all powers come unto you! May Mother Herself be your hands and mind! It is immense power – irresistible – that I pray for you, and, if possible, along with it infinite peace. .....
>
> If there was any truth in Sri Ramakrishna, may He take you into His leading, even as He did me, nay, a thousand times more! (*Letters of Swami Vivekananda: Web*).

The last letter to Sister Nivedita dated 4th March, 1902, from Varanasi, clearly shows that Swamiji had prepared himself for the final journey. He wrote to Margo [Margot]:

> It is night now, and I can hardly sit up or write, yet still feel duty bound to write to you this letter, fearing lest it becomes my last, it may put others to trouble.

He had a low fever which almost never left him. With it, there was difficulty in breathing. He wrote that Swami Ramakrishnananda had come to him and had laid down at his feet Four hundred Rupees which he had collected in four years (*Swami Vivekananda Complete Works: Web*). Swamiji was moved. He instructed Nivedita to make arrangements so that the amount was paid back to Swami Ramakrishnananda if he passed away. He conveyed his blessings to her and Swami Ramakrishnananda. He ended the letter with the following lines:

> I am quite satisfied with my work. To have left two true souls is beyond the ambition of the greatest.

Ever yours loving father, VIVEKANANDA

Incidentally, both Swami Ramakrishnananda and Sister Nivedita passed away in 1911, Ramakrishnananda on 21st August (Chetanananda, Swami 308) and Nivedita on 13th October, as documented in *Bhogini Nibedita* (Muktiprana, Pravrajika 446).

From 7th June, 1896 to 4th March, 1902, we get different moods of Swami Vivekananda in his letters addressed to Sister Nivedita. We see how the relationship between the two great souls evolved with time. Finally, in his last letter to Nivedita, Swamiji declared her as one of the two great souls – the other being Swami Ramakrishnananda – he was leaving behind. This was, in his own words, "beyond the ambition of the greatest".

Works Cited

- Letters of Swami Vivekananda, Third (New) Edition, October 1970, Published by Swami Budhananda, President, Advaita Ashrama, Mayavati.
- Sister Nivedita, The Master as I saw him, Eleventh Edition, 1972, Published by Swami Niramoyananda, Udbodhan Office, 1 Udbodhan Lane, Baghbazar, Calcutta.
- Pravrajika Muktiprana, Bhogini Nibedita, Ninth Edition, May 2012, Published by Pravrajika Debaprana, Secretary, Ramakrishna Sarada Mission Sister Nivedita Girls' School, 5 Nivedita Lane, Kolkata.
- Letters of Sister Nivedita, Volume Two, Collected and Edited by Sankari Prasad Basu, April 1982, Published by R. Saha, Nababharat Publishers, 72 Mahatma Gandhi Road, Calcutta.
- Marie Louise Burke, Swami Vivekananda, His Second Visit to the West New Discoveries, Second Edition, February 1982, Published by Swami Ananyananda, President, Advaita Ashrama, Mayavati.
- Letters of Swami Vivekananda, Web 13 Feb 2017, rkmathbangalore.org/Books/**Letters** %20 of %20 **Swami** %20 **Vivekananda pdf.**
- SWAMI VIVEKANANDA COMPLETE WORKS (Vol 9) – HolyBooks.com, Web 13 Feb 2017, www.holybooks.com/. . ./ **SWAMI VIVEKANANDA** – COMPLETE – WORKS – Vol 9. **pdf**.
- Swami Chetanananda, God Lived With Them, First Indian Edition, October 1998, Third Reprint, May 2006, Published by Swami Bodhasarananda, President, Advaita Ashrama, Mayavati

নারীশক্তি ও উচ্চশিক্ষা

জয়া চৌধুরী
অধ্যাপক, স্প্যানিশ বিভাগ, রামকৃষ্ণ মিশন, গোলপার্ক

ভগিনী নিবেদিতার জন্মের দেড়শ' বছর পূর্তি উদ্‌যাপন উপলক্ষ্যে এই কলেজে আসতে পেরে নিজেকে কৃতার্থ লাগছে। তিনি যখন পাশ্চাত্যের প্রাচুর্য ছেড়ে পরাধীন ভারতের দুয়ারে এসেছিলেন তখনই জগত চোখ তুলে চেয়েছিল বিস্ময়ে। আমাদের রোজকার চাওয়া ও ভোগলিপ্সার যুগে দাঁড়িয়ে কল্পনা করতেও অবাক লাগে যে, এক আইরিশ নারী, যার ছিল ব্রিটিশ শাসনের বিরুদ্ধে রুখে দাঁড়ানোর ঐতিহ্যবাহী কেল্টিক রক্ত, সেই তিনি দৃপ্ত চক্ষু, কপর্দকশূন্য রাজপ্রতিম সন্ন্যাসী স্বামী বিবেকানন্দের আহ্বানে তাঁর সারা জীবনের সব জাগতিক সুখসম্ভাবনা ছেড়ে চলে এলেন পরাধীন ভারতে। ইতিহাস বইতে আমরা গত ১০০০ বছরে যে নবজাগরণের কথা পড়ি তার মধ্যে প্রথম নামটি হল ইতালীর নবজাগরণ ও আমাদের বঙ্গদেশের ঊনবিংশ শতকের নবজাগরণ। এর শুরু হয়েছিল রাজা রামমোহন রায়, বিদ্যাসাগর ইত্যাদি মনীষীর হাত ধরে। সেই সময় বরণীয় মানুষজন বহুভাবেই চেষ্টা করছিলেন নারীদের অবস্থার উন্নতির জন্য। তার মূল স্তম্ভ শিক্ষার প্রসারেও তাঁদের কারো কারো উদ্যোগ ছিল অসাধারণ। কিন্তু স্বামীজি যখন মার্গারেট নোবেলকে আহ্বান করলেন এদেশে আসবার জন্য, তখন বলেছিলেন, "আমাদের দেশে বীর নারী প্রয়োজন অবস্থার উন্নতির স্বার্থে, কিন্তু জননী ভারতমাতা তা যতদিন প্রসব করতে না পারেন ততদিন তোমার মত নারীরই দরকার এদেশের নারী শক্তি জাগরণের জন্য।" নিবেদিতা তখনই ছিলেন ইংল্যান্ডের বিদ্বৎসমাজে অত্যন্ত খ্যাতনামা ব্যক্তিত্ব, এমনকি তখনকার পত্রপত্রিকা পড়লে জানা যায় তাঁর মধ্যে ভবিষ্যতে ইংল্যান্ডের প্রধানমন্ত্রী হবার সম্ভাবনাও দেখেছিল কেউ কেউ। কিন্তু তিনি সে সব ছেড়ে চলে এলেন কোন বিদেশ বিভুঁইয়ে, কত না দারিদ্র্য মেনে নিয়ে। তারপর তিনি কিভাবে শত অপমান, প্রত্যাখ্যান সহ্য করে ধীরে ধীরে মেয়েদের ইস্কুল গড়েন সে ইতিহাস আমরা তো জানিই। ভারতের স্বাধীনতা আন্দোলনের সশস্ত্র সংগ্রামের ইতিহাসেও নিবেদিতার অপরিসীম অবদান ছিল। অনুশীলন সমিতির নেতারা, যেমন বারীন ঘোষ, অরবিন্দ ঘোষ ইত্যাদিরা যে প্রভূত সাহায্য ও উৎসাহ নিবেদিতার কাছ থেকে পেয়েছিলেন, তা আমাদের জানা। বিদেশী রীতির স্থানে আধুনিক চিত্রকলাকে উৎসাহ দিতে অবনীন্দ্রনাথ ঠাকুর, নন্দলাল বসু প্রমুখকে তিনি কিভাবে উৎসাহ দিয়েছিলেন, কিংবা বিজ্ঞানী জগদীশচন্দ্রের প্রতিভার পিছনে তাঁর কতখানি সস্নেহ উৎসাহ ও সহায়তা সেকথাও ইতিহাস খুললেই জানতে পারব। কিন্তু এসবই শুরু হয়েছিল প্রথমেই যখন তিনি জননী সারদার সঙ্গে দেখা করতে যান স্বামীজীর সঙ্গে বাগবাজারে মায়ের বাড়িতে। সেই অল্পবয়সী আচারনিষ্ঠ হিন্দুঘরের বিধবা মা তাঁকে "খুকী" বলে অবলীলায় কাছে টেনে নিলেন যেদিন, সেদিন থেকেই বস্তুত নিবেদিতার "ভারতসাধনা"র প্রথম দ্বারটি অনায়াসে উন্মোচিত হল। আসলে নারী মানেই তাকে "অবলা" আখ্যায় ভূষিত করার যে চিরকালের সমাজ আরোপিত চেষ্টা তার মুখের ওপর সপাট জবাব মায়ের এই আচরণ, যেখানে ধর্মীয় গোঁড়ামি ছেড়ে

ISBN : 978-81-933395-0-3

বিদেশিনীকে স্বদেশের কাছে গ্রহণযোগ্য করে তোলা বড়ই অবলীলায় ঘটে। গায়ের জোর থেকে যে বল উৎপন্ন হয় তার চেয়েও মনের দৃঢ়তার বল যে বহুগুণ শক্তিশালী মায়ের এই আচরণে তাই দেখি আমরা। দেড়শ বছর আগে নারীর অবনমিত অবস্থা আত্মমর্যাদাহীন অবস্থা থেকে উত্তরণের জন্য নিবেদিতা যে চেষ্টা করেছিলেন, সারদা দেবীর ঐকান্তিক আশীর্বাদে আজ তা মহীয়ান রূপে দিকে দিকে ছড়িয়ে পড়েছে। নারীর জাগরণের জন্য শুধু এদেশেই নয় পাশ্চাত্যেও বহু বছর আগেই বিভিন্ন নারী চেষ্টা করে গিয়েছেন।

সাহিত্য নিয়ে কাজ করার জন্য বিশেষত স্প্যানিশ-বাংলা অনুবাদ নিয়ে কাজ করার সুবাদে পৃথিবীর বহু দেশের হিস্পানিক সাহিত্যে নারী শক্তির জাগরণে বিভিন্ন সাহিত্যিকের কাজ চোখে পড়েছে। এ বিষয়ে সবচেয়ে উল্লেখযোগ্য দুটি নাম আজ আমি উল্লেখ করব। প্রথম জন হলেন সর খুয়ানা ইনেস দে লা ক্রুস বা সিস্টার খুয়ানা ইনেস। আজ থেকে ৫০০ বছর আগে স্পেন দেশের সাহিত্যে নতুন ভাষার সৃষ্টি হয়, স্পেনীয় সাহিত্যের দিকবদল হয় যুগান্তকারী। আর এই বদল যার হাত ধরে আসে তিনি হলেন মিগেল সেরভান্তেস সাভেদ্রা। সেরভান্তেস হলেন প্রবাদপ্রতিম 'ডন কুইকজোট' বা 'দোন কিখোতে দে লা মাঞ্চা'র রচয়িতা। ১৪৯২ সালে কলম্বাসের আমেরিকা আবিষ্কার করার পরে ইউরোপে বিশেষত স্পেনে অনেক ওলটপালট হয়ে যায়। সেসময় ইংল্যান্ডে শেক্সপীয়র সৃষ্টি করছেন 'রোমিও জুলিয়েট' ও স্পেন দেশে ফেরনান্দো দে রোখা একসঙ্গে করছেন 'লা সেলেস্তিনা'। উপন্যাস দুটির কাহিনী ও সংলাপ হুবহু এক প্রায়। এই সময়েই স্পেন মেক্সিকোসহ সব লাতিন আমেরিকার দেশগুলি ক্রমাগত জয় করতে থাকে এবং তাদের সংস্কৃতি, ভাষা আগুনের মত ছড়িয়ে যায় সেসব দেশে। এইরকম সময়েই সর খুয়ানা জন্ম নেন মেক্সিকোয়। স্প্যানিশ বাবা ক্যাপ্টেন ছিলেন স্পেনীয় বাহিনীর, মা ছিলেন ক্রিওইয়া অর্থাৎ দাসী। অবৈধ শিশুটি ব্যাপ্টাইজড হন 'গির্জার সন্তান' পরিচয়ে। শিশুকাল থেকেই তাঁর জ্ঞানের কথা সুবিদিত ছিল। তিনি প্রথমে ১৬ বছর বয়সে যোগ দেন কারমেল শাখার মঠে। কিন্তু দু'বছর পরেই সেখান থেকে সরে যোগ দেন হেরোনিম শাখার মঠে এবং সেখানেই বাকী জীবন কাটান। এই নারী ছিলেন গ্রীক ভাষায় পারদর্শী, ১৩ বছর বয়স থেকে লাতিন ভাষা পড়াতেন তিনি। নিজে দক্ষ ছিলেন মেক্সিকোর আদিম জাতি নাউয়াটল-এর আযতেক ভাষায়, এই ভাষায় তিনি বেশ কিছু কবিতাও লেখেন। একথা মনে করলে অবিশ্বাস্য লাগে যে এই বিদুষীর পাণিপ্রার্থী ছিলেন অনেক তাবড় তৎকালীন বিদ্বজ্জন, কিন্তু তিনি সে সব অবহেলায় প্রত্যাখ্যান করে বিশেষ করে ঝাঁপিয়ে পড়েন তাঁর সাহিত্য কর্মে। নারী স্বাধীনতা বলতে আমরা এখন যা বুঝি, তার আদি জননী বুঝি তিনিই। সেই হেরোনিম মঠের চার দেওয়ালের মধ্যে, তাঁর ব্যক্তিগত বিশাল লাইব্রেরীর নিভৃতে তিনি আজীবন যা লিখেছেন তার বিরুদ্ধে সে সময়ের ক্ষমতাবান ব্যক্তি অনেকেই মতামত সংগ্রহ করতে থাকেন। জনতাকে তার বিরুদ্ধে ক্ষেপিয়ে তোলার যতই চেষ্টা হয় ততই তাঁর জনপ্রিয়তা বাড়তে থাকে লাফিয়ে লাফিয়ে। ফাদার আন্তোনিও ভিয়েরার নামে বিশপ মানুয়েল ফেরনান্দে তাঁর বিরুদ্ধে ধর্ম-বিরোধী কাজ করছেন বলে বই ছাপান। ধর্মনিরপেক্ষতার প্রচার ছেড়ে সর খুয়ানা যেন ধর্ম প্রচারে অধিক মন দেন সে জন্য হুমকি দিতে থাকেন। কিন্তু স্পেনের ভাইসরয় ও তাঁর স্ত্রী ছিলেন তাঁর পৃষ্ঠপোষক। তাই শত বিরোধিতা সত্ত্বেও খুয়ানা ইনেসের সব লেখা স্পেন থেকেই প্রকাশিত হতে থাকে। এখানে একটি নমুনা দিলাম তাঁর কবিতার—

Quejase de la Suerte অদৃষ্টকে গাল পাড়া
সর খুয়ানা ইনেস দে লা ক্রুস
অনুবাদ—জয়া চৌধুরী

আমার পশ্চাৎ ধাবনে, পৃথিবী, তোমার আগ্রহ কীসের?
তোমার কোনখানে আঘাত দিয়েছি আমি? যখন আমি স্রেফ

আমার বোধগম্যতায় সৌন্দর্য লেপন করতে চাইছি
আমার সৌন্দর্যকে বোধগম্যতায় নয়?

পরিমাপ করি না আমি আমার বৈভব আমার ঐশ্বর্য রাশি
আর এভাবেই, বরাবর তৃপ্তি পেয়ে থাকি বেশি
বরং ঐশ্বর্যকে বোধগম্যতায় আরোপ করি
বোধগম্যতাকে ঐশ্বর্যের মধ্যে নয়।

পরাস্ত রূপরাজির পরিমাপ করি না আমি
যুগ যুগ ধরে সে তো নাগরিক নগ্নিকরণ মাত্র
আমাকে তুষ্ট করে বিশ্বাসহীনতা, নয় ঐশ্বর্য রাশি।

আমার সত্যগুলিকে গ্রহণ করতে করতে
জীবনের অহংগুলিকে ধারণ করতে থাকার চেয়ে
অহং এর ভেতর জীবনকে ধারণ করা ঢের ভাল।

হিস্পানিক সাহিত্যে নারীর মহিমা তুলে ধরার আর যে দ্বিতীয় উল্লেখযোগ্য নাম — তিনি হলেন গাব্রিয়েলা মিস্ত্রাল। ১৯৪৫ সালে চিলির এই নারী সাহিত্যে নোবেল পদক লাভ করেন। শোনা যায় রবীন্দ্রনাথ ১৯১৩ সালে নোবেল পাওয়ার পরে তাঁর কবিতা ইংরাজীতে পড়ে মিস্ত্রাল এত অনুপ্রাণিত হয়েছিলেন যে তাঁকে নিয়ে বেশ কটি প্রবন্ধ লেখেন। শুধু তাই নয়, কয়েকটি লেখা স্প্যানিশ ভাষায় অনুবাদও করেন। কিন্তু তার চেয়েও বড় কথা হল রবীন্দ্রনাথের দর্শন পড়ে তিনি প্রচণ্ড উদ্দীপ্ত হন। পাশ্চাত্যে নারীর জায়া রূপটি অধিক আদৃত এবং তা নিয়ে সাহিত্যে শিল্পে কত সহস্র সৃষ্টিই হয়ে চলেছে। নারীর মাতৃরূপটি বিশেষভাবে প্রাচ্যের বৈশিষ্ট্য। মিস্ত্রাল ব্যতিক্রমীভাবে সাহিত্যে মা ও সন্তানের সম্পর্কের ওপর জোর দিয়েছেন। অসংখ্য কবিতায় তিনি তুলে ধরেছেন মায়ের মন যা পৃথিবীর সর্বত্র একই সুরে বাজে এবং সে রূপ ফুটিয়েছেন ছত্রে ছত্রে। তিনি তো শুধুই কবি ছিলেন না, আধুনিক চিলি ও মেক্সিকোর শিক্ষাব্যবস্থারও ধাত্রী জননী তিনি। ছুটে ছুটে বেড়িয়েছেন অসংখ্য লাতিন আমেরিকার দেশে আর প্রচার করেছেন শিক্ষা পদ্ধতির নবতম রূপ। নারীর শিক্ষা কেমন হবে শুধু তাই-ই নয়, শিশুদের শিক্ষা কেমন হওয়া উচিত, সে বিষয়ে তাঁর ছিল অগ্রপথিকের ভূমিকা। বাংলা ভাষায় রবীন্দ্রনাথের যে প্রভাব, মিস্ত্রালের দেশে শিশুপাঠ্যের বই থেকে লক্ষিত হয় মিস্ত্রালের প্রভাব। এখানে তাঁর একটি কবিতার উদাহরণ দিয়ে রাখলাম —

একা খোকা
সারা উবনের-কে

কান্নার শব্দ কানে আসতেই, চড়াইয়ের গায়ে থেমে গেলাম
পথের মাঝে থাকা র‍্যাঞ্চের দরজার কাছে এগিয়ে গেলাম।
মিষ্টি মুখের এক খোকা ওর বিছানা থেকে আমার দিকে তাকাল
এক অসম্ভব কোমলতা, ঠিক যেন ওয়াইন আমাকে মাতাল করে তুলল।
মা-টি দেরী করছিল, পতিত জমিতে নুয়ে পড়েছিল;
খোকা জেগে গিয়ে সেই গোলাপের বৃন্ত খুঁজছিল

কান্নায় ভেঙে পড়ল... আমি ওকে বুকে জড়িয়ে নিলাম,
একটা কাঁপা কাঁপা ঘুমপাড়ানি গান, আমার গলায় উঠে এল।
খোলা জানলা দিয়ে চাঁদটা আমাদের দেখছিল।
ততক্ষণে খোকা ঘুমিয়ে পড়েছে, আমার বুকটা ভরে উঠছিল।
আর ঠিক তখন, মা-টি ভীরু হাতে দরজাটা খুলে দিল,
যে মানুষটা আমার কোলে ঘুমন্ত ছেলেটি রাখতে দিয়েছিল সেই
ভাগ্যবতী মুখটা আমার এত দেখতে ইচ্ছে করছিল!

বিঃ দ্রঃ - সারা উবনের ওরফে মাগদা সুদেমান চিলির বিখ্যাত নারীবাদী সাংবাদিক ও সাহিত্যিক ছিলেন বিংশ শতকের প্রথমার্ধে।

নারীর ক্ষমতায়ন নিয়ে কথা বলতে গেলে আমরা যেমন সভ্যতার ইতিহাসে নারীর প্রতি শোষণ, আগ্রাসন ও বঞ্চনার কথা তুলে ধরি, ঠিক তেমনই তাদের স্মরণ করিয়ে দেওয়াও প্রয়োজন, শোষণের থেকে চাকা ঘুরিয়ে নিজে ক্ষমতায় এলে যেন পাল্টা শোষণের সমাজ না গড়ে তোলে সে। মারের বদলা মার — এই পদ্ধতি কিছুকাল সাফল্য লাভ করবে। কিন্তু দীর্ঘ সময়ের ইতিহাসে তা সমাজে শান্তি গড়ে তুলবে না। আসুন আমরা যেন ভগিনী নিবেদিতার জন্মের দেড়শ বছর পূর্তির এই শুভক্ষণে আমাদের দায়িত্বের কথা না ভুলি, আমাদের মনুষ্যত্বের কথা না ভুলি, যেন পুরুষের সঙ্গে হাতে হাত মিলিয়ে সমাজকে নতুন আলোর পথে এগিয়ে নিয়ে যেতে পারি।

সকলের কল্যাণ হোক।

BLOOD SUCKING MOSQUITO

Sabyasachi Sarkar
Honorary Visiting Professor
Nanoscience and Artificial Leaf Laboratory at Downing Hall,
Center for Healthcare Science and Technology
Indian Institute of Engineering Science and Technology-Shibpur,
Botanic Garden, Howrah 711103, West Bengal

Mosquito emerged in this earth dated back to Jurassic period, 100 million years ago as per the fossil record trapped in amber glue found in Burma. This geological period synchronized with the rise of dinosaur and thus led to the interesting novel followed by movie, 'Jurassic Park'. The base theme of the movie has been to get the DNA from the blood in the gut of a fossilized mosquito of that period. It was presumed that as humans were not emerged in that period so the blood meal of the mosquito must be from readily available large animals like dinosaur and so genetic scientists created Jurassic park with living dinosaurs using trans-genetic method. Much later in the latest part of the Quaternary period of the earth the genus Homo evolved and diverged from other hominins and finally the single subspecies Homo sapiens (modern Humans) evolved to colonize all the continents and larger islands, arriving in our land around 125,000–60,000 years ago. Between the time frame of 100 million to around 100,000 years of human age, mosquitoes diverged to around 2700 species and surprisingly only few of these versions require blood meal for the development of their egg.

Fig. 1 : Mosquito fossilized and trapped in amber glue (~ 100 million years ago)

In this timeline one should consider misquotes are real sons or daughters of this soil rather than humans. Therefore mosquitoes have the right to stay in this world and they normally serve as a food chain in creating ecological balance. It is irony that mosquitoes prefer human blood than animals and in doing so they transmit some deadly diseases via their saliva. Interestingly animals have protecting defense

ISBN : 978-81-933395-0-3

mechanism and any manifestation of such diseases do not recur to the animals or these diseases remain dormant in animals like pig or dog.

To name few of these mosquito borne diseases are Malaria and Fileria and recent are dengue, encephalitis, chikungunya and most recent is Zika virus. All these diseases collectively kill millions of people in this world and could be the worst killer comparable to the human causalities took place in the World War II. In the modern day communication and transportation mosquitoes in the form of egg are moved from one continent to other continent via cargo shipment and so spread throughout the world and merrily breed in warm and sultry environment.

Humans do not feel mosquito bite at the initial stage when they sting because of the inherent chemistry and physiology associated in the process of blood sucking. A protein of hemoglobin class called nitrophorin is synthesized by mosquitoes which stay in their saliva. There are few variant forms of nitrophorin similar to hemoglobin but essentially all these forms function in the same way. Hemoglobin is a metalloprotein where an iron is centrally placed to carry oxygen required for our tissue for burning food for metabolic activity. Nitrophorin is very similar to hemoglobin protein containing an iron in the center of it but instead of dioxygen (O_2) it carries a similar small diatomic molecule, nitric oxide (NO). This nitric oxide is a very important molecule and even humans synthesize it inside as mosquitoes do with the help of an enzyme called NO-synthase. But humans use NO for different purpose and its most important function is related to vasodilatation and its role as neurotransmitter for short term memory. This iron containing protein, nitrophorin, carries NO and mosquito on stinging immediately injects nitrophorin inside human blood stream from its saliva. As hemoglobin carries dioxygen to release it near tissue so is nitrophorin which releases NO once came in contact with blood. It happens because the saliva of mosquito is acidic (pH of saliva = 5.6) and in such an environment NO remained bonded to nitrophorin but as it reaches in the blood which is basic in character (pH of blood = 7.4), the NO is released in the blood. This creates two quick physiological function like NO being vasodilator inflates the blood vain so more of blood flows to help its drinking and secondly the iron site of the nitrophorin protein remains now vacant. It is like a vacant chair inviting some suitable molecule to sit. The immunology in the human body starts its action as soon the stinging invasion of the mosquito took place. The B and T(lymphocytes) cells are activated to command histamine for an on the spot enquiry and its report can help to identify the nature of repair to deal with the inflicted damage. The histamine molecule never goes back to report the damage because the vacant iron sit allures it and histamine molecule binds to iron and stayed back there . So the nature of damage is not reported to relevant immunological section to take relevant action and this is reflected in human behavior as we do not feel any problem during mosquito's blood meal time. The process of releasing more NO from more nitrophorin continues by mosquito and more batches of histamine from immunological defense mechanism reaches to the biting spot to conduct enquiry gets bind and captured by iron of the nitrophorin and therefore could not report back the extent of damage. It is only when the mosquito is satisfied with its blood meal and pull out its sting from the body then the next fresh batch of histamine reaching the damaged spot complete the enquiry to report back as there is no more free iron containing nitrophorin to stop its movement. The body defense mechanism now started its action to repair the damaged part as manifested by cutaneous

edema with inflammation and allergic reactions around the bitten spot. Therefore it is understandable that the Nature has taken care by developing an interesting mechanism by which mosquitoes can penetrate human body defense system for their essential blood meal.

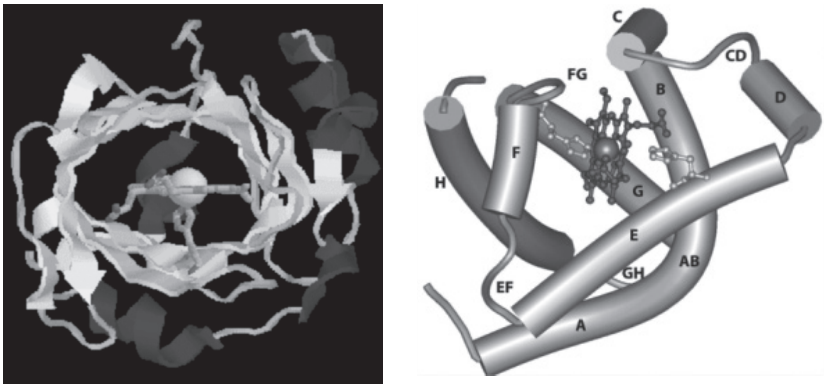


Fig. 2 : Nitrophorin structure–(a) Ribbon like part is polypeptide. The cyan ball is iron at the center imbedded inside the heme group. (b) A part of hemoglobin and theme group with iron in the middle.

The main human concern now is how to stop mosquito bite to prevent the spread of mosquito borne diseases. Mosquito vectored diseases include Malaria, Chikungunya, Dengue,Yellow Fever, Encephalitis, West Nile Virus, Zika Virus, Filariasis. There are approximately 2,700 species of mosquito in the world and it's only the females from just 6% of the mosquito species that draw blood from humans to help them develop their eggs. The three most significant genera are the Aedes, Anopheles, and Culex, as these types of mosquitoes carry parasites that cause human diseases. Among these Aedes prefer mammalian hosts and will preferentially feed on humans, even in the presence of alternative hosts and even act in day time. They also feed on multiple hosts during one gonotrophic cycle.

The most primitive preventive measure from mosquito bite is quarantine under net which may not be comfortable in day time and under sultry humid weather where ventilation and air conditioning facilities are largely not available. The alternate is fogging in the absence of sunlight (dusk time) to prevent decomposition of few spreading chemicals and also to get larger outing of mosquito population. The pesticides chemicals routinely used are Scourge, Anvil, Permethrin, and Malathion. The fogging does not affect mosquitoes in larval or papal stage so there remains a continuous flow of new generation mosquitoes as reinforcement. The liquid vaporizer mosquito repellent used in home mainly contain these pesticides in low dose. There is no report available but immunity under continuous use of similar drugs to several generations of mosquitoes is bound to set in. On the other hand all of these pesticides are by large neurotoxins affecting central nervous system and are carcinogens. The vapors of such chemicals may directly cross the blood brain barrier via easy nasal path and may affect brain.

The poisoning of these pesticides either used in fogging or as liquid vaporizer or creating localized higher concentrated pesticides vapor camouflaged with perfume vapor by direct burning is a slow process like passive tobacco smoking where there is none to measure the progress in damage which affect more to children, pregnant

women and old people. Therefore all the chemicals used against mosquitoes are health hazard especially in longer use and also useless in the absence of newer chemicals as mosquitoes have developed immunity.

For an alternate way to irradiate mosquito recently some British farm have genetically modified (GM) the males of Aedes aegypti. These GM males carry a gene that stops their offspring developing properly. This second generation of mosquitoes then die before they can reproduce and become carriers of disease themselves. Meanwhile, scientists in the US have bred a GM mosquito with a new gene in the laboratory that makes it resistant to the malaria parasite. Field trials using GM mosquitoes have been a moderate success but involved releasing millions of modified insects to cover just a small area. Getting every female mosquito to breed with sterile males in a large area would be very difficult. Instead one should like to combine this with other techniques. Such strategies may be more difficult to get approved because they would make an entire wild population transgenic. Moreover, this will be costly approach.

Bacillus thuringiensis israelensis and Bacillus sphaericus commonly called Bti and Bs, are larvicides made from naturally-occurring bacteria. The bacteria destroy the guts of the larvae causing them to die. These bacteria do not hurt people or pets, even if consumed, because the digestive systems of people and pets are much different from mosquitoes. Maintaining bacteria pool will be cumbersome to handle. Methoprene is a man-made larvicide that is similar to a chemical normally found inside mosquito larvae that controls their development. Methoprene stops larvae from developing into adult mosquitoes. This product has no effect on people or pets at the low dose used for mosquito control but strict monitoring would require to control the dose.

Mosquitoes feed on plant nectar and are important pollinators. They are in the food chain cycle of birds, bats, and as larvae are consumed by fish and frogs. Mosquitoes sustain tropical rainforests till now inhabitable to human and thus these forests are saved. Attempting mass extinction of mosquitoes in such a way may have undesirable side effects.

Innovative ways of tackling mosquitoes are being developed across the world. Meanwhile, how female mosquitoes are attracted to certain body odours, raising hope for more effective repellents. Another promising avenue is to make mosquitoes resistant to the parasites that cause the diseases. In Australia, naturally occurring bacteria is used to reduce the ability of mosquitoes to pass dengue between people. Sensor are being developed that can detect each different species of mosquito from its distinctive wing beat and with wearable acoustic detectors to track disease-bearing mosquitoes.

Surface films made from oil or higher alcohols may prevent the growth of mosquitoes. The formation of a thin layer over the surface of the water where mosquito larvae or pupae are present may prevent these to breathe. Mosquito larvae and pupae have air tubes that they use to breathe at the surface of the water. Surface films suffocate the mosquito larva or pupa by preventing their air tubes from acquiring oxygen at the water's surface. These products are not poisonous to humans, and pets are not harmed by drinking from a pond sprayed with these products. Common adulticides like pyrethrins are chemicals obtained from chrysanthemum flowers and are poisonous to insects. But sunlight destroys pyrethrins very fast, so such bio-friendly chemicals are destroyed within an hour when exposed to sunlight. Pyrethrins block parts of the mosquito's nervous system causing death. Human can be sensitive to pyrethrins and may feel a

tight or tingly feeling under their skin, soreness around their eyelids, or a scratchy throat if they are exposed. Pyrethroids are man-made chemicals similar to pyrethrins. Pyrethoids last longer in sunlight than pyrethrins (up to a couple of days). Pyrethroids work very similar to pyrethrins to kill adult mosquitoes. But aquatic animals including fish are sensitive to pyrethroids and thus cannot be spread in water. Piperonyl butoxide (PBO) is a chemical that has little effectiveness as a pesticide by itself, but when it is added to products containing pyrethrins or pyrethroids it makes them work better. PBO makes it harder for the mosquito to get rid of the pesticide from their body. When PBO is used, less active ingredient is needed to kill mosquitoes. There is no harm to humans and/or pets when PBO is used in mosquito spraying.

Everyday new form of mosquito borne diseases are discovered. Recently Zika virus appeared in the scene that affect pregnant women inflicting malfunction in the growing child inside the womb. People are looking for antibodies against Zika in several blood samples from ongoing dengue studies in Columbia, Thailand, India, and parts of Africa. The US National Institutes of Health (NIH) and the Thai Armed Forces Research Institute of Medical Sciences, meanwhile, will add retrospective and prospective Zika surveillance to existing dengue cohort studies.

Antibodies against Zika, dengue, and other flaviviruses are notoriously cross-reactive. When someone contracts Zika in a dengue-endemic area, such as Brazil and Nicaragua, current diagnostic tests can't distinguish between antibodies made against the two viruses.

Currently, researchers and health care providers rely largely on clinical symptoms and positive antibody tests to diagnose acute Zika infections. They can also reasonably distinguish antibodies made during a new Zika infection from those made against dengue years earlier.

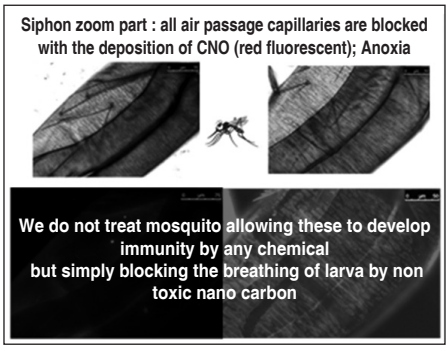


Fig. 3 : Anoxic effect of nano carbon.

To inform researchers about the longevity of immune responses to Zika and its potential to induce herd immunity, any new serological assay will have to work months or years after infection.

We in Kolkata have developed a nano carbon treatment. Here we developed low cost water-soluble nano carbon by burning wood waste. The distribution of this stuff in 3 ppm level in water stopped the growth of mosquito larva by anoxia. It blocks the siphon breathing of larva causing suffocation and finally death. Interestingly nano carbon are non toxic to all fauna and flora including human and also mosquito. But its special physical property in blocking the siphon part of the breathing mosquito larva is unique. Also this low cost nano carbon is indestructible so once used stays there to work for years.

150th Birth Anniversary Celebration

CHEMICALS THAT ARE KILLING SILENTLY

Goutam Paul*, Partha Pratim Nath, Kaushik Sarkar,
Panchali Tarafder, Mukti Mondal
*Presenting Author
Professor, Department of Physiology, Kalyani University

Introduction

We live in the world of synthetic chemicals. More than 80,000 chemicals are sold commercially in the market of India. In addition, 600-800 new synthetic chemicals are entering into the market annually. Most of the chemicals we use are pesticides, followed by food additives and cosmetic ingredients. The non-target harmful effects of all chemicals we use have not been tested fully till date. The harmful effects of only 2 percent of all chemicals we use have been reported. The aim of this article is to disseminate the knowledge about toxic effects of some familiar synthetic chemicals we use in our daily life based on research outcomes in my research laboratory.

1. *Chemical Teratogens*

Teratogens are agents that cause human birth defects (physical or functional). Teratogenic agents may be chemical substances, physical factors, or biological agents. In this paper only the chemical teratogens are considered in characterization. Some chemicals we use as medicines to cure ailments, a food additives, social drugs, and cosmetic ingredients produce physical birth defects in live-born human babies when pregnant mother is exposed to those chemicals in the period of organogenesis (in the early period of gestation, *i.e*; 3rd week to 8th week) as confirmed by the results of experiments in rat model in my laboratory. A table is given below for identification of some

Table 1: List containing known and suspected teratogens

Known Teratogens	Possible or Suspected Teratogens
A. Chemical agents	Aspirin
1. Drugs: Thalidomide, Aminopterin, Isotretinoin, Amphetamine, Progesterone (Hormone)	Certain Antibiotics Antitubercular drugs, Barbiturates
2. Chemicals (Social drugs): Alcohol, cocaine	Iron Tobacco
3. Chemical compound: Methyl mercury	Antacids Excess Vitamin A,D Certain Insecticides Herbicides, Fungicides

ISBN : 978-81-933395-0-3

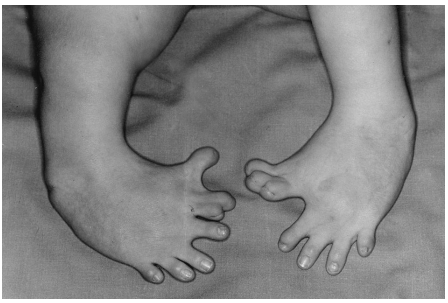


Fig. 1 : Amelic (physical) symptom in an infant.

representative (confirmed) chemical teratogens and the probable birth deformities caused by them.

Birth defect is the leading cause of infant mortality below the age of 5 years in India. This type of social malady could be avoided through social awareness about the use of those killer teratogenic chemicals, particularly during the period of gestation.

Table 2: Chemical teratogens and their probable involvement in physical birth defects

Chemical Teratogens	Birth Defects
Thalidomide Aminopterin	Limb defects (amelia, meromelia etc), heart malformations
Amphetamine Alcohol Isotretinoin (Vit. A analog)	Anencephaly, hydrocephaly, cleft lip and palate Cleft lip and palate Heart defects, mental retardation
Organic Mercury and Lead	Small abnormal shaped ears, cleft palate and lip, heart defects Multiple neurological disorders

2. *Metanil yellow*

Metanil yellow (monosodium salt of 3[[4-(phenylamino) phenyl] azo] benzenesulfonic acid) is a synthetic dye and is specially used in leather, textiles and paper industries as a coloring agent. It is very cheap and easily available in the market. Presently, metanil yellow is used to color some food products as substitute of organic dye permitted as non toxic food additive of some food products like laddoo, jalebi, amriti and to color besan, turmeric powder and other spices.

The percentage amount of metanil yellow contamination in some food items (laddoo, jalebi, amriti, besan, biryani prepared by organized and unorganized sectors in 6 districts in West Bengal, state of India have been determined. We found majority of the food samples collected from unorganized sectors contain metanil yellow at levels above the maximum permissible limit as stated in the charter of Prevention of Food Adulteration Act of India (PFA, 2008). Subsequently, the effects of metanil yellow on the estrous cycle rhythmicity in female rats and on the functions of ovary and uterus have been examined to elucidate the effects of metanil yellow on the female reproductive system functions. We found distinct functional alterations in estrous cycle rhythmicity in metanil yellow exposed female rats. Besides, the molecular structural degenerations

of the uterus and ovary in metanil yellow exposed rats have been observed due to promotion of oxidative stress. The levels of female reproductive hormones have also been decreased significantly in metanil yellow exposed rats. Metanil yellow also produced inhibition of folliculogenesis and thus impairment of the production of ovum in female rats; and

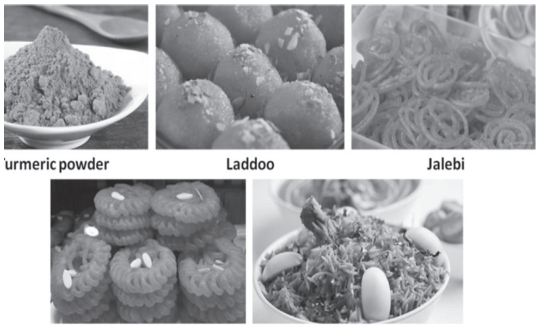


Fig. 2 : Food items commonly added with metanil yellow.

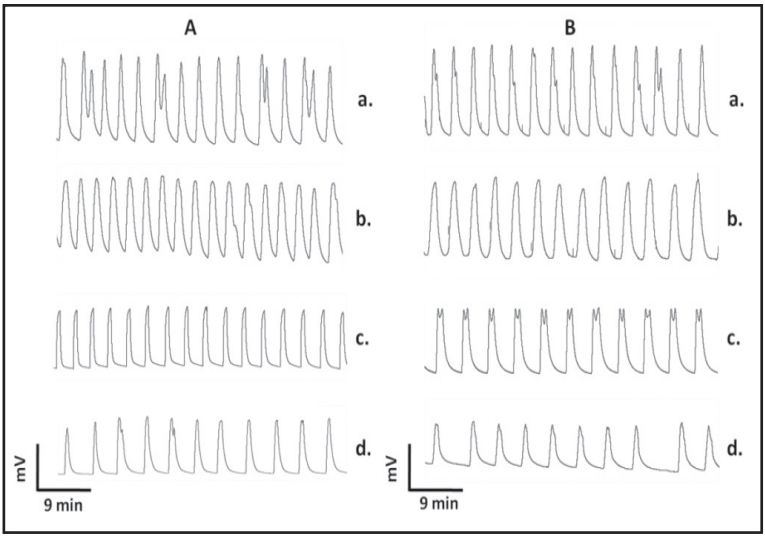


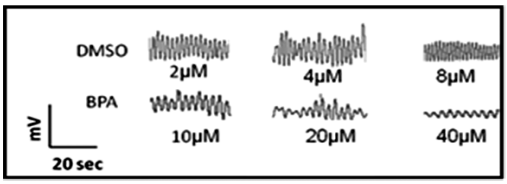
Fig. 3 : Effects of metanil yellow on the movement of uterus in rat.

inhibited the contraction of uterine smooth muscles by changing the mode of activation of autonomic and non adrenergic non cholinergic (NANC) efferents. In conclusion, it may be said that metanil yellow depresses the female reproductive functions in rats.

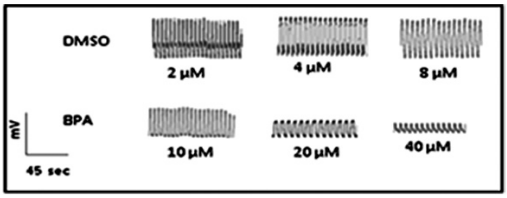
Many of the food products available in the countryside markets in districts of West Bengal state, India are probably contaminated with metanil yellow. The amount of MY present in the food products is probably higher than the maximum permissible limit as prescribed by Prevention of Food Adulteration Act of India (PFA, 2008). The exposure of human beings to MY for a longer period of time might produce severe health hazards due to molecular interactions of MY with several biomolecules.

3. *Bisphenol A (BPA)*

Bisphenol A (BPA) is a controversial industrial chemical. Its monomeric form is used in the industry to produce polycarbonate plastic, the raw material for the making of bottle for packaging drinking water, baby feeding bottle, and different forms of empty bottles for storing drinking water in indoor and carrying drinking water in the outdoor



(A)



(B)

Fig. 4 : Records of the effects of BPA on the movement of intestine (A) and heart (B) in rat and toad models.

as portable manner. Besides, BPA is used to produce epoxy resin, the thin plastic material used to coat the inner surface of the metal container used for the packaging of foods or food ingredients.

It has been proved that a considerable amount of monomeric forms of BPA continuously leaches from the polycarbonate plastic walls of the bottle or resin coatings of the metal cans to the water or food stored in normal room temperature. So, humans, including the babies, are silently exposed to the BPA through BPA contaminated foods or drinks.

BPA has been considered as an environmental estrogen. Because, BPA produces the estrogen (the principal female reproductive hormone) like effects in human beings when it enters the body through dietary or other exposure routes. Its toxic effects on different system functions have been reported based on experiments in animal model. We have found that BPA depresses the function of small intestine by inhibiting the basal motility, and depresses the functions of heart by inhibiting the force and frequency of cardiac rhythmicity in animal models. Thus, we draw the attention of the common people about the deleterious health impacts of BPA due to the use of BPA products by this article.

4. *Ajinomoto*

Ajinomoto is a very popular flavor enhancing food additive. Its chemical name is monosodium glutamate (MSG). Ajinomoto is commonly found in Chinese dishes,

Fig. 5 : Ajinomoto commonly added to prepare the food items listed above.

pastries, candies, jellies, chips, milk, and different dishes of meat, fish and vegetables. Though its human health impacts has been established in case of Chinese Restaurant Syndrome, the scientific investigation about the effects of Ajinomoto on different systems of the human body are lacking till recently. In rat model, we have shown that

Ajinomoto impairs the estrous cycle; increases the blood level of female reproductive hormones, like LH, FSH and Estradiol (E_2); and potentiates the movements of uterus in female rats. These results indicate that Ajinomoto may impair female reproductive functions in human beings.

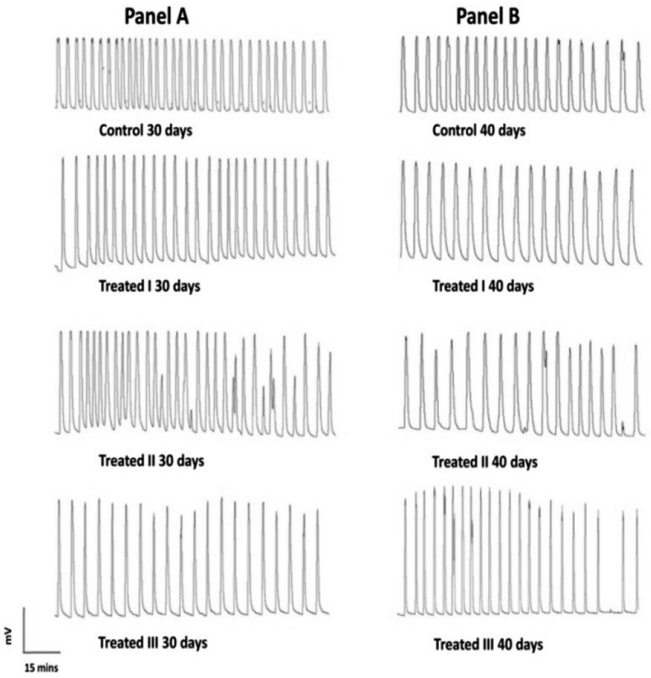


Fig. 6 : Effects of Ajinomoto on uterine movement.

Conclusion

Most of the chemicals we have examined are toxic to living organisms. So, we cannot ignore the probable deleterious impact of those chemicals in human beings. We suggest full biological characterization of the chemicals before their commercialization for the use of humans either directly or indirectly.

BIO-REVOLUTION AND PROGRESSIVE LIFE: REAL STORY OF INDIA

Syamal Chakrabarti
Department of Chemistry, University of Calcutta

Availability of food is not everything for a progressive life. We also need other essentials such as clothing, shelter, education and health. Noted agricultural economist Utsa Patnaik in a public lecture on April 10, 2004 on the occasion of 50th birthday of Safdar Hasmi initiated her speech by saying, 'In the course of last five years (1998-2003), the population of the Republic of India has been sliding down towards sharply lowered levels of per capita food grains absorption, levels so low in particular years that they have not been seen for the last half century. Between the early 1990s when economic reforms began, and at present, taking three-year averages, the annual absorption of food grains per head has come down from 177 kg to 155 kg. Such low absorption levels were last seen in the initial years of World War II – from where they had fallen further still.' Prof. Patnaik also stated that the steep and unprecedented fall in food grain absorption in the last five years has entailed a sharp increase in the numbers of people in hunger.

In the month of October 2016, International Food Policy Research Institute (IFPRI) ranked India low 97th among 118 countries in 2016 Global Hunger Index (GHI). The study of the neighboring countries may be given here.

Country	*Rank*	*GHI Score*
China	29	7.7
Nepal	72	21.9
Myanmar	75	22
Sri Lanka	84	25.5
Bangladesh	90	27.1
India	97	28.5
Pakistan	107	33.4

Only for Pakistan, the situation is worse than India.

Debating the social causes, we do not attempt to make the subject matter a political issue. We will turn our attention towards scientific solution. Lots of people are prescribing for genetically engineered germplasms. Government of India is giving emphasis on this issue through different agricultural and horticultural organizations. India is a biodiversity rich country. Introduction of GM-foods require lot of introspection. We cannot forget the concern expressed by Prof. M. S. Swaminathan, a leading agricultural scientist of the world few years back where he stated that Terminator technology could

ISBN : 978-81-933395-0-3

deal a fatal blow to millions of resource-poor farmers in developing countries. (Asha Krishna Kumar, Frontline, Vol 15, No. 21, 1993)

Terminator technology, more scientifically known as genetic use restriction technology (GURT) yield 'suicide seeds'. Here the genetically modified plants produce seeds which may be used as food but they are sterile in nature. The technology was developed by the 'Agricultural Research Service' of the 'United States Department of Agriculture' in collaboration with a corporate organization named 'Delta and Pine Land Company' during 1990s. There are two types of Terminator technology. In one case, the seeds are produced, as already mentioned, can be used as food or fodder but could not be used as seeds. In the second case, the genetically engineered crop will not function if the crop plant is not treated with a chemical (activator) which is only sold by the biotechnology company. The first process will not make any immediate impact on the Western farmers as they purchase specialized hybrid seeds from seed production companies. But most of the developing countries including India largely use seeds saved from the earlier harvest. Thus, the impact in these countries will be dreadful.

The conference of the parties to the convention on Biological Diversity held in Brazil from 20 to 31 March 2006 had to face protest raised against 'terminator technology'. There was a question in the conference whether governments should allow the use and sale of genetically modified 'terminator seeds'. We quote a report from the desk of Inter Press Service News Agency circulated on 21 March 2006.

> "*…..as delegates arrived at the conference venue, they faced more than 100 peasant and indigenous rights activists at the main gates staging a demonstration in support of a complete ban on the sale and use of Terminator seeds, officially known as Genetic Use Restriction Technology.*
> *'These seeds are killed seeds', the co crowd shouted as they watched delegates arrive in cars and buses*."

The protestors shouted the slogan 'Terminate the Terminators' and also demanded tough laws against field testing and sale of 'Terminator' technology.

Though UN Convention on Biodiversity had adopted a resolution for temporary prohibition on field testing and commercialization of 'Terminator technology' in 2000, the agitators feared that the seeds may be marketed unless the governments impose a total ban. We can mention the statement of a farmer from Zambia, 'In my culture we don't buy seeds. We save them. But now somebody is trying to bring agriculture slavery for us.' The protestors mentioned that 'Terminator technology' would not only undermine traditional knowledge and innovation but would add to the economic burden of poor peasants who depend on saved seeds. A member of Canada-based Action Group for Erosion, Technology and Concentration (ETC) stated that the 'Terminator Technology' is designed to maximize profits for the biotech industry because farmers will be forced to buy seeds every year. His statement is believable because each year the global commercial seed market brings in about 23 billion dollars in revenue. If the Terminator technology is implemented world-wide, the global market will be more than 45 billion dollars. ETC estimated that the global seed producers will earn at least 10 billion dollars from the farmers of the developing countries.

ETC also stated that the Brazilian farmers will have to pay no less than 500 million dollars a year to buy soybean seeds whereas the peasants of Pakistan had to pay more than 120 million dollars a year for buying wheat and cotton seeds. The scenario is a

truth because presently about 80 percent of farmers of Brazil and Pakistan grow crops based on seeds saved from previous harvests.

Many governments in the developing world have so far resisted pressure from the US government and industry but some governments in the industrialized world are trying to influence negotiations in favor of the industry. The demonstrators clearly noted that rich countries like Australia, Canada and New Zealand will side with U.S.A. Representatives of Australia were well ahead in this regard. During January 2006, there was a discussion on 'Terminator technology'. When people thought to ban terminator seeds, representatives from Australia diluted the situation by saying that the technology may be considered on 'case to case basis'. Francisco Rodriguez, a woman representing indigenous people's group of Chile mentioned, 'It's about our food security. You don't have food security if you don't have seeds.'

Monsanto and the followers of this US based biotech giant advocated the genetically engineered crops in order to fight hunger. 'Friends of the Earth', a well known environmental group of the world recently has released a study material of about 100 pages entitled 'Who Benefits from GM Crops?' According to their report, 'after 10 years of GM crop cultivation, more than 80 percent of the area sown with biotech crops in situ concentrated in only three countries – US, Argentina and Canada.' Are these countries suffering from hunger? Answer is obviously 'No'. Their interest was only to serve the biotech transnationals.

There were illegal GM crop plantation in Brazil and Paraguay. They were planted in Indonesia after the government officials were bribed. Why plantation in Brazil was illegal? In 2005, the government of Brazil, a major agricultural producer passed a law prohibiting the use, registration, patenting and licensing of modified seeds.

What about India? India is an agro-based country of about 135 crores people. It is a fact that GM crops were not introduced in India until 2002. Let us take the example of GM Cotton. Indian farmers are used to cultivate a variety known as tree cotton (*Gossypium arboretum*). The fibers are longer, finer and whiter than the wild cousins. But since this plant is native to India, it can also handle failed monsoons. It suits the soils and it can beat the local pests.

After the introduction of GMO crops, the situation has altered totally. There was an article in the 'Washington Post' on 30 December 2016 written by Esha Chhabra titled 'The dirty secret about your cloths'.

Let us record few lines from the article.

> *"Dyeing is only one part of the manufacturing process. The clothing material itself, namely cotton, poses a separate threat to farmers. Only a decade ago, Indian farmers planted 80 percent of their crop using seeds saved from cotton grown the year before. But the advent of genetically modified (GMO) seeds drove that tradition out of the market. Farmers were originally attracted to the GMO varieties because they produced bigger yields than natural seeds, and were supposed to be weed-resistant.*
>
> *But once they stopped replanting natural cotton seeds, those varieties disappeared from the local agriculture. Today, more than 90 percent of Indian cotton comes from GMO seeds, which has forced farmers into a cycle of debt, according to Vandana Shiva, an agricultural activist. GMO seeds are expensive, and because GMO plants don't produce fertile seeds of their own,*

new seeds have to be brought each season. Furthermore, pesticides are used on the GMO cotton fields.

Since 2004, however, a cooperative that now numbers more than 35,000 organic-cotton and fair-trade Indian farmers is forgoing chemicals, and building a new seed bank of non-GMO cotton seeds."

Dr. Vandana Shiva, a very well known ecological activist wrote an article in April 2013 titled 'The Seeds of Suicide: How Monsanto Destroys Farming' in 'Asian Age and Global Research'. She described the secret plan of Monsanto for earning money. According to Dr. Shiva, "Patents on seed are illegitimate because putting a toxic gene into a plant cell is not 'creating' or 'inventing' a plant. These are seeds of deception – the deception that Monsanto is the creator of seeds and life, the deception that while Monsanto sues farmers and traps them in debt, it pretends to be working for farmers' welfare, and the deception that GMOs feed the world. GMOs are failing to control pests and weeds and have instead led to the emergence of superpests and superweeds."

In 1995, Monsanto introduced its Bt-technology in India through a joint-venture with the Indian Company Mahyco. In 1997-98, Monsanto started open field trials of its GMO Bt-Cotton illegally and announced that it would be selling the seeds commercially the next year. According to the Environment Protection Act 1989, it was mandatory to get approval from the Genetic Engineering Approval Committee (GEAC) for GMO trials. There was a case in the Supreme Court against Monsanto. The company was not allowed to start sales of the Bt-Cotton seeds until 2002. A Parliamentary Standing Committee was formed under the chairmanship of Basudeb Acharia. The committee submitted a report during August 2012 where it was mentioned that 'The committee has come to the conclusion that since concerns on the potential and actual impacts of GM crops to our food, farming, health and environment are valid, GM crops are just not the right solution for our country.' It must be remembered that before making conclusion, the members of the Parliamentary Committee travelled throughout India and consulted various stakeholders including farmers, farmer union leaders, biotechnology industry representatives, relevant departments of the central government, state government, scientists and civil society members. At the same time, the Supreme Court recommended a 10 year moratorium on field trials of all GM Food and termination of all ongoing trials of transgenic crops.

It was also stated in the Shiva's article that an internal advisory group was formed by the agricultural ministry of India in January 2012 to look into the situation of cotton growing states in India. The group reported, 'Cotton farmers are in a deep crisis since shifting to Bt-cotton. The spate of farmer suicides in 2011-12 has been particularly severe among Bt cotton farmers.'

Let us now present the issue of Bt-brinjal. Bt-brinjal is a transgenic brinjal created by inserting a crystal protein gene (Cry1Ac) from the soil bacterium *Bacillus thuringiensis* into the genome of various brinjal cultivators. Brinjal is a low calories and fats containing vegetable and contains mostly water, some protein, fibre and carbohydrates. It is also a very good source of minerals and vitamins and rich in water soluble sugars and amide proteins among other nutrients. It is an important source for Ayurvedic medicine and is of special value in the treatment of diabetes and liver problems. Brinjal is a major food crop in India. ICAR and Mayhco, after a joint research, suggested that 42% pesticide reduction and doubling of the crop yield is possible by harvesting Bt-brinjal.

Mahyco submitted biosafety data to GEAC in 2006 and the same is approved by GEAC in 2007.

Indian Institute of Vegetable Research (IIVR) takes up the responsibility of large scale trials of Mahyco's Bt-brinjal at 10 research institutions across the country in 2007 and 11 in 2008. After that lot of points were expressed both for and against the release of Bt-brinjal. On February 9, 2010, the ministry of environment and forest imposed a moratorium on Bt-brinjal in the absence of scientific consensus in spite of the approval of GEAC. There were a number of public consultations before the moratorium.

The most recent episode is centering around the genetically modified mustard. There is a report in 'Nature', (541, 267-68, 19 January 2017) submitted by Sanjay Kumar where he mentioned that Deepak Pental, a plant geneticist at the University of Delhi got clearance from GEAC but finally it was stopped because of a lawsuit. If it was allowed, it should be the first GM-crop in India. The present national government after coming into power approved some field trials during 2014. During September 2016, the ministry of environment put green signal to GM mustard (*Brassica Juncea*). Dr. Pental demanded a 25-30% increase in GM-mustard harvesting. When everything is almost set to run, Aruna Rodrigues filed a case in the Supreme Court on 7 October 2016. Aruna raised the issue of contamination of neighboring plants from the transgenic mustard. Pental did not consider this an important issue. But Imran Siddiqi, a biologist from CCMB, Hyderabad said differently. According to him "you cannot ignore the issue of contamination. It will have to be assessed very carefully." Suman Sahai, a former member of GEAC sought a higher level of technical competence specially for biosafety. She also filed a case long back. Both Aruna's and Suman's cases are awaiting verdicts from the Supreme Court. There is no doubt that GMO harvesting is debatable not only in developing countries but also in most of the European countries. The answer coming out from the domain of science will be universal in nature. Let us all wait for that. We should never forget that the backbone of India is its agriculture.

150th
Birth Anniversary
Celebration

"BENGAL RENAISSANCE" AND ITS IMPACT ON TROPICAL DISEASES RESEARCH IN CALCUTTA

Asoke Chandra Ghose
Professor (retd.) of Microbiology, Bose Institute, Kolkata

The Principal, faculty, students of the college, ladies and gentleman.

It gives me great pleasure to visit your college and participate in the year-long celebration programme to pay homage to the noble lady Sister Nibedita on the occasion of her 150th birth anniversary. All of us are aware of her immense contribution towards the social as well as intellectual empowerment of Indian women, particularly at a time when the country under the British rule needed it most. Although a foreign national by birth and up-bringing, her interaction with local people (common as well as intellectuals) considerably influenced socio-political scenario of Bengal during early twentieth century. "She fought for higher education in science in India. She strived to bring the Indian traditional thought in a harmonious synthesis with the Western thought in philosophy, humanities, and many other subjects ..... She sought to bring a unique way of representing Indian motifs in visual arts and influenced the pioneers of the reawakening of Indian art. She inspired numerous freedom fighters to give up concessionary politics and fight for freedom. She stood for women rights at a time when such attempts were practically unheard of in India". Keeping all these in mind, she can truly be considered as one of the flag-bearers of the "Bengal Renaissance" movement which had started in the late eighteenth century (with Raja Rammohan Roy) and notionally continued till India received independence. The period witnessed the emergence of a large number of personalities who were well-educated with liberal ideas and contributed significantly in socio-cultural reforms as well as in diverse areas such as education, literature, philosophy, fine arts etc. The impact was also felt in the field of science and medicine, particularly during the late nineteenth and early twentieth century. Establishment of educational institutions with research motivation facilitated the achievement of academic excellence by a number of brilliant scientists who earned worldwide acclaim through their scientific contributions. In this lecture, I will try to focus on some of the seminal contributions made in the field of biomedical sciences by scientists/clinicians working in Calcutta during the late nineteenth and early twentieth century.

Incidentally, Bengal and its adjoining areas were also frequently subjected to a number of calamities like famine, epidemics etc during this period. Tropical diseases, for example; malaria, kala-azar, cholera, plague, small-pox etc were rampant in the form of outbreak or epidemic leading to high incidence of mortality and morbidity

ISBN : 978-81-933395-0-3

amongst people living in the area. As a result, considerable attention was focused on health care and research with the ultimate objective of better understanding of the disease process and their control. Establishment of premier hospitals and medical colleges in Calcutta (Table I) facilitated the development of basic infrastructure and manpower to achieve the objective. Although the early initiative was taken by the British doctors working in India, emergence of a crop of well-trained and dedicated medical researchers and practitioners from Bengal helped in taking over the baton from their British counterparts. Consequently, major breakthroughs could be achieved in our understanding of the underlying cause and mode of transmission of some of the diseases like malaria, kala-azar and cholera resulting into the development of effective therapeutic and preventive measures. The seminal work of Ronald Ross (on malaria), Upendra Nath Brahmachari (on kala-azar) and, later on, by Sambhu Nath De (on cholera) need special mention. It is pertinent to note that these discoveries, made in Calcutta through studies carried out with limited resources and infrastructure, considerably stimulated the interest of contemporary as well as next generation researchers.

Sir Ronald Ross

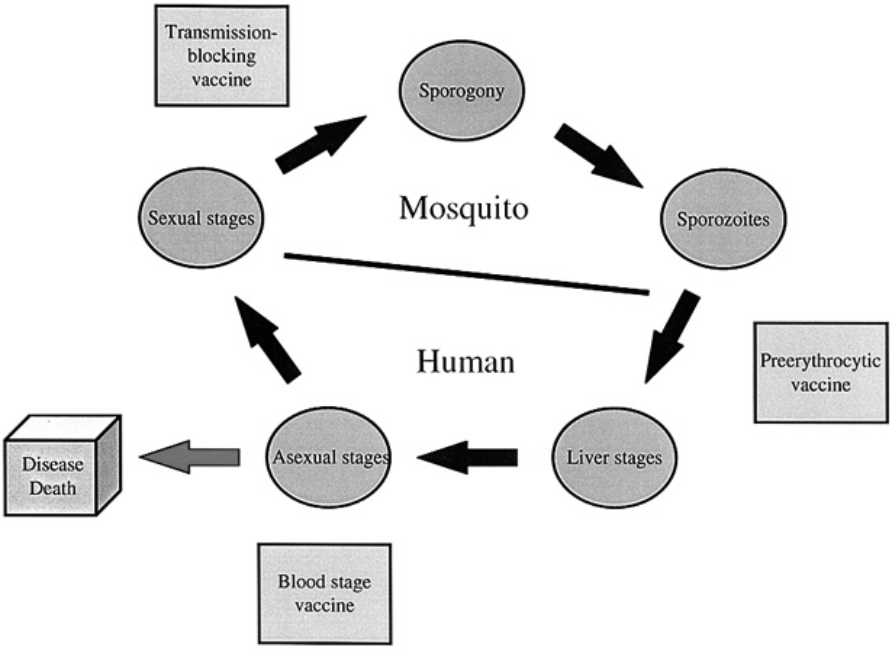
PG Hospital Laboratory where Ronald Ross worked on Malaria

Sir Ronald Ross (1857-1932)

Ronald Ross, a British citizen, was born in Almora (India) in the year 1857. On completion of his education in medicine, he joined Indian Medical Service in 1881.

He became interested in malaria research from 1892 and started working to determine the role of mosquitoes on its transmission. While working in Secunderabad, he demonstrated that the anopheline mosquitoes to be the carriers of malaria parasites in man (1897). The finding was published in British Medical journal in 1897. Subsequently, he was transferred to Calcutta in 1898 where he started working on avian (bird) malaria in PG Hospital.

Here, he established the complete life cycle of malarial parasites in the vector (mosquito) and susceptible host. He returned to England in the year 2000. In the year 1902, Ronald Ross was awarded Noble prize for his seminal work on malaria and its transmission.



Malarial parasite life cycle in man

Sir Upendra Nath Brahmachari (1873-1946)

UN Brahmachari was born in Jamalpur (Bihar) in the year 1873. He had a brilliant academic career and was well trained in basic as well as medical sciences that immensely helped him in his research pursuit. In the year 1905, he joined Campbell Medical School (later on known as NR sarkar Medical College and Hospital). During this period, a disease called "kala-azar" was highly prevalent in parts of Eastern India including in Bengal. The disease was associated with a high degree of mortality as there was no effective treatment available at that time.

Sir Upendra Nath Brahmachari

Realising that there was an imperative need for the development of an effective drug to combat the disease, he started working towards the goal. After years of pain-staking research, he finally developed (1922) the compound "urea stibamine" and demonstrated it to be effective in the treatment of kala-azar. Despite initial scepticism, his discovery received recognition from concerned authority as the drug was extensively used in the epidemic-prone regions in Assam and Bengal. Sir John Kerr, the Governor of Assam in his address to the Assam Legislative Council noted that "The progress in the campaign against kala-azar in Assam has been phenomenally rapid and if it continued at the present rate there is excellent prospect of the scourge of the disease being brought under complete control in a few years. Dr. Brahmachari's research in the treatment

of kala-azar is the most outstanding contribution in tropical therapeutics as a result of which three lakhs of human lives were saved in the Province of Assam during the course of ten years". HE Shortt, Director, Kala-azar Commission in India (1932) noted "We consider that the value of urea stibamine has been established as the most efficient drug at present in the treatment of Indian kala-azar. It (urea stibamine) was a dramatic success. A death rate of 90% was transformed into a cure rate of 90%". The comparative efficacy of the two drugs, 'urea stibamine' and 'neostibosan', was also investigated in other countries such as France (1934), China (1935), Greece (1937), Sudan (1940). The tests had shown 'urea stibamine' to be superior to 'neostibosan' as anti-kala-azar drug. Brahmachari was nominated for Noble prize in the year 1929 and received 'knighthood' for his contribution in kala-azar.

Another important milestone in the career of UN Brahmachari was his finding (1922) that the syndrome of "dermal leishmanoid" noted in people living in the kala-azar endemic area is a sequel to kala-azar, which he later termed as "post kala-azar dermal leishmaniasis" or PKDL. The work of Brahmachari is the success story of a dedicated researcher who, despite all limitations, could achieve his goals to alleviate the sufferings of a large number people (children and adults) affected with the life threatening disease like kala-azar. In his presidential address at the Royal Asiatic Society meeting (1929), he himself summarized his experience by reminiscing "I shall never forget that room where urea stibamine was discovered. The room where I had to labor for months without a gas point or a water tap and where I had to remain contended with an old kerosene lamp for my work at night. The room remains, but the sign of a laboratory in it have completely disappeared. To me it will ever remain a place of pilgrimage where the first light of urea stibamine dawned upon my mind". UN Brahmachari was also a man of great knowledge and vision as is clearly evident in his presidential address at the 23rd Indian Science Congress (1936) "The future trend of creative evolution, including man's own destiny, depends on his response to the new knowledge and on his intelligent appreciation of genetical discoveries in the near as well as distant future. Genetics, aided by better environment, may also be able to prevent the transmission of hereditary weakness or diseases…. In this way it may lead to the production of better type of man, free from diseases of the mind and body".

Sambhu Nath De (1915-1985)

Cholera is an acute type of diarrheal illness that affected millions of people around the world over the centuries. Historically speaking, there are only few diseases that are comparable to cholera in terms of its severity and explosive onset in the form of an outbreak or epidemic. It was Robert Koch (a German scientist) who identified the comma shaped cholera bacterium (known as *Vibrio cholerae*) as the causative agent of the disease. Interestingly, Koch made this discovery in 1983-84 while working at Calcutta Medical College for a short time.

Dr. Sambhu Nath De

However, while incriminating *V. cholerae* as the organism responsible for cholera he could not fulfil all the postulates (known as "Koch's postulates") that he had proposed earlier to establish the casual relationship between

an infectious micro-organism and the disease. This was due to non-availability of any experimental animal model of cholera at that time. It was a matter of great coincidence that 70 years later (1953) an Indian scientist Sambhu Nath De, for the first time, developed an animal model of cholera in rabbits (known as "rabbit ileal loop model") working in the same laboratory at Calcutta Medical College. He demonstrated (1959) that the massive diarrhea in cholera patients was caused by a toxin (an enterotoxin known as "cholera toxin") released by the organism *Vibrio cholerae* multiplying in the intestine. The discovery of cholera toxin was shown to be of profound importance not only in cholera and related enterotoxigenic enteropathies but also served as an useful model to explain the mechanism of action of polypeptide hormones, growth factors and related molecules of biological interest.

Born in a small village in the district of Hooghly in 1915, De received his initial education in a local school. Being a meritorious student, he could support his education through scholarships. He obtained his medical degree from Calcutta University in 1939 and joined medical service in 1942. Twice he went to UK for higher research and received Ph.D (1949) and D.Sc. (1962) degrees from London University. He was the Professor and Director of Pathology, Calcutta Medical College, at the time when he made his fundamental discovery on cholera toxin. Unfortunately, his work failed to receive adequate recognition from the contemporary scientific community. This as well as lack of financial and infrastructural support, administrative bureaucracy did not allow him to pursue his discovery further to take it to newer heights. He retired from service in the year 1973. However, his contribution was recognised later on when he was invited and honoured in the Nobel Symposium on cholera 1978. In the year 1986, Eugene Garfield wrote an article in Current Contents (vol-14, p.143) where he discussed the impact of the work of SN De of Calcutta. In the article Garfield reflected on the significance of SN De's papers, two of which eventually attained "citation classic" status. Garfield proposed the concept of delayed recognition and concluded that De's 1959 paper in Nature, while initially unrecognized, today is considered a milestone in the history of cholera research". Prof. John Craig of New York University commented on De's work, "No matter how simple it may now seems, we are compelled to recognize that this was a truly creative and novel piece of work which started a chain of events which, in turn, forever altered our concepts surrounding the secretory diarrhea". Joshua Lederberg (a Noble Laureate), who had nominated SN De for Noble prize, wrote "Our appreciation for De must then extend beyond the humanitarian consequences of his discovery……. But he is also an exemplar and inspiration for boldness of challenge to the established wisdom, a style of thought that should be more aggressively taught by example as well as concept". The hallmark of De's work on cholera was his motivation to research and uniqueness of ideas that could be carried out through simple experiments. However, unlike many scientists, he was averse to publicity which probably cost him dearly in the form of lack of resources, manpower and eventually 'lack or delayed recognition'. His frustration becomes evident if one goes through his letter written to his great friend and admirer Prof. van Heynenginen of Oxford University, "Workers in developed countries cannot imagine how difficult it is to carry out and continue research work without willing personnel and without

equipment in an undergraduate teaching department in the country like ours". Similar tone of sadness was also reflected in his concluding remark made in the Noble Symposium before the august gathering, "Chairman and Friends, before I conclude I wish to make a few personal remarks. I have been dead since the early 1960s, I have been exhumed by the Nobel Symposium Committee and these two days with you make me feel that I am coming to life again".

Table 1: Medical college and Hospitals established in Bengal during the pre-independence period

Name	Year
Presidency General Hospital (SSKM Hospital)	1770
Mayo Hospital	1792
Calcutta Medical College(Medical College Bengal)	1835
Campbell Medical College (NRS Medical College)	1873
Carmichael Medical College (RG Kar Medical College)	1886
Calcutta School of Tropical Medicine	1914

150th
Birth Anniversary
Celebration

TOXINOLOGY – AN EMERGING AREA IN BIOMEDICAL SCIENCE & ITS THERAPEUTIC APPLICATION

Dr. Subir C. Dasgupta
Professor & Head, Department of Zoology
Maulana Azad College, Kolkata 700013
E-mail : subirdgupta@gmail.com

Toxinology is the specialized area of science that deals specifically with animal, plant, and microbial toxins. It deals also with the biology of venom- or poison-producing organism, the structure and function of the venom apparatus, venomous animal bye products as well as the use of the venom or poison for therapeutic uses. Toxinology has also been defined as the science of toxic substances produced by or accumulated in living organisms, their properties, and their biological significance for the organisms involved. All venom is multifaceted and multitasking. (The difference between venom and poison is that venom is injected, or dibbled, into victims by way of specialized body parts, and poison is ingested. Dozens, even hundreds, of toxins can be delivered in a single bite, some with redundant jobs and others with unique ones. In the evolutionary arms race between predator and prey, weapons and defenses are constantly tweaked. Drastically potent concoctions can result: Imagine administering poison to an adversary, then jabbing him with a knife, then finishing him off with a bullet to the head. Ironically, the properties that make venom deadly are also what make it so valuable for medicine. Many venom toxins target the same molecules that need to be controlled to treat diseases. Venom works fast and is highly specific. Its active components—those peptides and proteins, working as toxins and enzymes—target particular molecules, fitting into them like keys into locks. It's a challenge to find the toxin that hits only a certain target, but already top medicines for heart disease and diabetes have been derived from venom. New treatments for autoimmune diseases, cancer, and pain could be available within a decade. Cobra venom, applied for centuries in traditional Chinese and Indian medicine, was introduced to the West in the 1830s as a homeopathic pain remedy. Advances in fields such as molecular biology continue to give scientists better ways to understand venoms and their targets. While drug companies once relied on luck, screening thousands of compounds for a particular effect, today's higher tech options, such as Designer Toxins, give sharper detail, making it easier to shape medicinal keys to fit specific molecular locks. The medical potential of venom is mind-blowing. But we are at risk of losing the sources of that potential faster than we can identify their toxin gifts. Snakes, in adapting to fill varied niches all over the globe, have evolved a stunning range of venomous compounds. But snakes are in decline, as are so many other animals. The oceans too are under pressure; their changing chemistry could wipe out promising sources of venom, from cone snails to octopuses. We should better

ISBN : 978-81-933395-0-3

appreciate molecular biodiversity. That would put the molecules in nature's deadliest potions high on the agenda when conservation decisions are made and that would be a lifesaver.

The spotted butterfish *Scatophagus argus* locally named as Pyrachanda is a common venomous fish in India. The spines are well equipped with venom glands. A sting of the fish *S. argus*, a venomous edible spotted butterfish, produces tremendous local pain, severe swelling, rise of body temperature, throbbing sensation etc. The pharmacological activities of *S. argus* sting extract, was established on experimental animals. The LD_{50} of extract was found to be 9.3 mg/kg (iv) in male albino mice. The extract showed loss of sensation, urination and salivation in mice. It potentiated pentobarbitone induced sleeping time in male albino mice and produced hypothermia. Extract produced a fall of cat and guinea pig blood pressure, which was completely abolished by mepyramine. It produced a transient reduction of respiratory rate in rat, but decreased respiratory amplitude in cat, which was abolished after vagotomy. On isolated toad heart, the extract increased both the amplitude and rate of contraction. On isolated guineapig heart, the sting extract decreased both the rate and amplitude of contraction leading to cardiac arrest, but it had no effect on isolated guinea pig auricle. The extract produced a reversible blockade of electrically induced twitch response of isolated chick biventer cervices preparation, but it had no effect on the isolated rat phrenic nerve diaphragm preparation. It produced a slow contractile response on isolated guinea pig ileum, rat uterus and rat fundal strip preparations but produced slow relaxation on isolated rat duodenum preparation. The contractile response on isolated guinea pig ileum and rat fundal strip was antagonised by SC19220. It did not produce any significant cutaneous haemorrhage in mice and did not produce any haemolysis on saline washed erythrocytes. The sting extract significantly increased capillary permeability of guinea pig dorsal flank and produced oedema in mice hind paw. An attempt has been made to develop antiserum in rabbit against *Scatophagus argus* sting extract. Antiserum did not neutralized the sting extract induced proinflammatory and haemorrhagic activity but successfully neutralized lethality upto $2LD_{50}$. Cyproheptadine, indomethacin and BW 755C pretreatment significantly reduced sting extract induced proinflammatory activity. The haemorrhagic activity of sting extract was significantly inhibited by temperature, UV-exposure, EDTA, cyproheptadine, indomethacin and BW755C pretreatment. The results conclude that the local effects of *S.argus* venom is likely to be mediated through release of mediators and may be encountered by pharmacological antagonists better than the antiserum (Muhuri 2004 & 2005). A haemorrhagic protein toxin (SA-HT) was isolated and purified from the spine extract of this Indian venomous butterfish, *S. argus* Linn, by two step ion exchange chromatography. The toxin was homogeneous in native and SDS-PAGE gel. SDS-molecular weight of the toxin was found to be 18.1 ± 0.09 kDa. SA-HT produced severe haemorrhage on stomach wall but devoid of cutaneous haemorrhage. UV, EDTA, trypsin, protease, cyproheptadine, indomethacin, acetylsalicylic acid and BW755C treatment significantly antagonized the haemorrhagic activity of SA-HT. The toxin produced dose and time dependent oedema on mice hind paw, which was significantly encountered by cyproheptadine, indomethacin and BW755C. SA-HT increased capillary permeability on guineapig dorsal flank. On isolated guineapig ileum, rat fundus and uterus, SA-HT produced slow contraction which was completely antagonized by prostaglandin blocker SC19220. On isolated rat

duodenum, SA-HT produced slow relaxation. SA-HT significantly increased plasma plasmin, serum MDA level and decreased serum SOD level indicating the possible involvement of cyclooxygenase and lipooxygenase pathway. (Karmakar et al 2004). Bidder's organ is a vestigial organ present in male species of Bufo. Bidder's organ extract was pharmacologically potent and contained several bioactive components. The presence of haemolytic protein was identified from Bidders organ. (Gomes et al 1996). BO extract produced both in vivo and in vitro anaphylactic reaction in guineapig. Dysopnea and bronchoconstriction was major cause of anaphylactic death. Blood histamine level was significantly increased (Gomes 2000).

Toxinological research has already reported the medicinal use of venom and toxins in different pathological conditions. Pain and inflammation are intimately associated with rheumatoid arthritis, a growing bone-joint related problem of the modern society. Though several therapeutic managements are available for arthritis, their side effects not only limit their use, but also advocate the quest for natural therapies.

An analgesic substance more potent than morphine was found from the venom of elapidae family snake *Bungarus fasciatus S*chneider, 1801, commonly known as banded krait, its venom contains neurotoxins, phospholipase A2, cardiotoxin, acetylcholinesterases and many other protein compounds. A serine protease, purified from BFV, was found to be an activator of factor X, and that, in the presence of Ca helps blood coagulation Cathelicidin BF, a cathelicidin-like antimicrobial peptide, purified from BFV proved to be an antibiotic. The antinociceptive, anti-inflammatory and antiarthritic activities of *Bungarus fasciatus* venom (BFV) was also worked out in experimental animal models. Rheumatoid arthritis was induced by Freund's complete adjuvant (FCA) in male Wistar albino rats. Lyophilized BFV was diluted in 0.9% NaCl. Antiarthritic activity showed that BFV significantly reduced the paw and ankle diameters; urinary hydroxyproline, glucosamine levels and serum ACP/ALP/TNF-a/IL-1ß/IL-17/ Cathepsin-K/MMP-1 levels. These parameters were significantly increased in FCA induced arthritic animals. Joint histopathology study indicated the partial restoration of joint structure. Treatment with BFV significantly reduced the mean latency time of tail flick response, acetic acid induced writhing response and formalin induced licking response in male albino mice. BFV treatment also significantly reduced carrageenan induced paw edema and xylene induced ear edema in male albino mice. The results indicated that BFV possess antinociceptive, anti-inflammatory. BFV showed anticancer activity also by inducing apoptosis of cancer cells and arresting cell-cycle progression in the checkpoints. However, there was no report on antiarthritic activity of BFV till date. In the present work, we tried to evaluate the antinociceptive, anti-inflammatory and antiarthritic activity of BFV in experimental animal models. (Ghosh 2016)

Anticancer drug development from natural resources is ventured throughout the world. Animal venoms and toxins a potential bio resource and a therapeutic tool were known to man for centuries through folk and traditional knowledge. The biodiversity of venoms and toxins made it a unique source of leads and structural templates from which new therapeutic agents may be developed. Venoms of several animal species (snake, scorpion, toad, frog etc) and their active components (protein and non-protein toxins, peptides, enzymes, etc) have shown therapeutic potential against cancer. In the present review, the anticancer potential of venoms and toxins from snakes, scorpions, toads and frogs has been discussed. Some of these molecules are in the clinical trials

ə

and may find their way towards anticancer drug development in the near future (Gomes 2010). Rheumatoid arthritis (RA) is one of the most common autoimmune disorder which causes swelling, redness, pain, stiffness, restriction of limb movements, decreases life expectancy and early death of the patients. Available drugs include non steroidal anti-inflammatory and analgesics, disease modifying anti-rheumatic drugs and steroids (glucocorticoids etc). All these drugs have their own limitations such as gastrointestinal irritations, cardiovascular problems, and drug dependency. Search for alternative therapy from natural products are being ventured throughout the world. Zoo therapy in arthritis, a common practice of the ancient times that have been mentioned in traditional and folk medicine. The scientific basis of some of the zoo products are being explored and have been showing promising results in experimental rheumatoid arthritis. These therapies have minimum side effects and many of them have potential to give rise to drug development clues against rheumatoid arthritis. The present review is an effort to establish the folk and traditional treatment of rheumatoid arthritis using zoo products. (Gomes 2011).

Similar bioactive components have been isolated from Indian black scorpion *Hetermetrus bengalensis* (Halder 2011). This study reports the presence of a high molecular weight protein (Bengalin) from the Indian black scorpion venom having antiosteoporosis activity in experimental osteoporosis developed in female albino Wister rats. Bengalin was purified through DEAE-cellulose ion exchange chromatography and high performance liquid chromatography. The molecular weight of the Bengalin was found to be 72 kDa and the first 20 amino acid sequence was found to be G-P-L-T-I-L-H-I-N-D-V-H-A-A/R-F-E-Q/G-F/G-N-T. Bengalin exhibited significant antiosteoporosis activity in experimental female rats, which was confirmed through analysis of urine Ca2þ, PO4 3, CRE & OH-P. Bengalin (3 mg and 5 mg/100 g rat/i.p.) antagonized osteoporosis by restoring urinary Ca2þ, PO4 3, CRE and OH-P, serum/plasma Ca2þ, PO4 3, ALP, TRAP, PTH, T3, TSH, Osteocalcin, IL1, IL6 and TNF a and bone minerals Ca2þ, P, Mg2þ, Zn2þ, Naþ, as compared with the sham operated control rats. Bone minerals density of osteoporosis female rats was improved due to Bengalin, observed through DEXA scan. Subacute toxicity studies in male albino mice, Bengalin showed cardiotoxicity. In vivo experiments, Bengalin showed cardiotoxicity on isolated guineapig heart, guinea pig auricle, and neurotoxicity on isolated rat phrenic nerve diaphragm preparation. Further detail studies on the toxicity, antiosteoporosis and structural identity of Bengalin are warranted.

The snake shed skin though considered as biological waste products have been mentioned in folk and traditional medicine for treatment of ailments like skin disorders, parturition problems etc. Shedded skin extract (5 $mg.kg^{-1}$, sc) did not produce any change in the estrous cycle of normal cycling female mice. However in 10 $mg.kg^{-1}$, sc dose, the extract caused a temporary cessation of the estrous cycle at diestrous phase in normal cycling female mice for 10 days. SSAE (10 $mg.kg^{-1}$, sc) caused a significant change in the level of LH, FSH, progesterone, estradiol, IL-1β, IL-6 and TNF-α. Histopathology of uterus and ovary showed structural disorientation in both. The results substantiate the influence of snake shed skin in mice reproductive cycle. (Mukherjee 2013).

The estrous cycle of female mice involved four phases: diestrous, metestrous, proestrous and estrous, it lasted for 4-5 days. It is regulated very intricately by endocrine

and cytokine circuitry. The short length and less complexity of the estrous cycle in mice made it ideal animal experimental model for study on reproductive cycle, including the effect of anti-fertility agents from natural sources. The female anti-fertility drugs generally prescribed by doctors are chemically steroids, available in a combination of estrogen and progestins, also known as oral contraceptive pills. The adverse side effects of the oral contraceptive pills included cardiovascular diseases, venous risk and metabolic disorder like lipoprotein changes, altered insulin response to glucose and prolonged use of those even might lead to endometriosis . The nonsteroidal anti-fertility drugs *e.g*. Gonadotropin-releasing hormone analogues (goserelin, leuprolide triptorelin) that are marketed in place of steroidal contraceptive pills also have severe side effects, affecting the central nervous system, associated CNS depression. Hence search of newer alternatives for female contraception from natural products is going on and is still a challenge to scientists' globally. Snake shed skin has long been used in the Chinese traditional medicine for various disorders including malignant sores, such as mammary abscess and tumor, boils, carbuncles, and furuncles. The shedded skins are usually roasted and then used both internally and topically. The snake shed

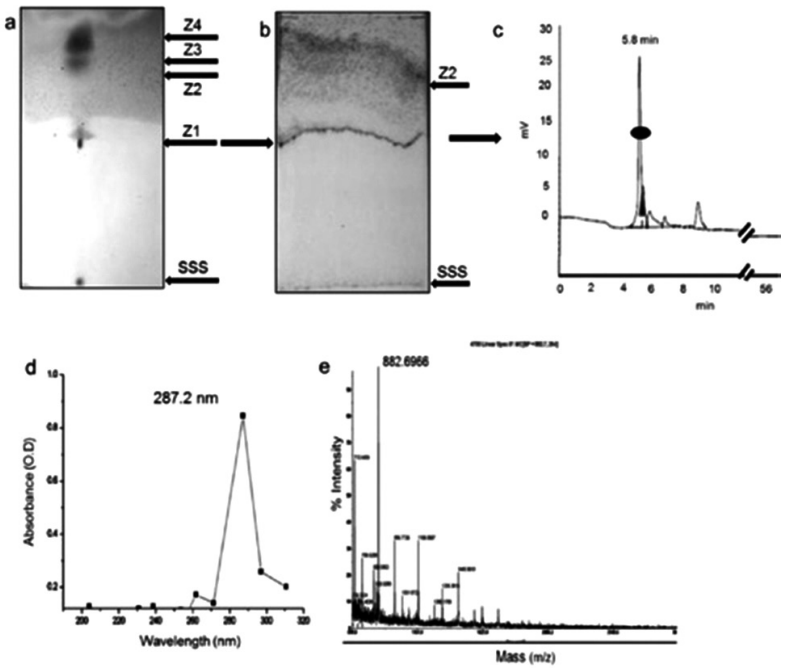


Fig. 1: Isolation, purification of NNSS2. (a) Thin layer chromatography of *Naja naja* shedded skin resolved into four zones using solvent system isopropanol: 0.1 N HCl (70:30, v/v); (b) Preparative thin layer chromatography using solvent isopropanol: 0.1 N HCl (70:30) was resolved into 4 zones (Zone 1 - Zone 4). Zone 2 was isolated and eluted in methanol; (c) RP-HPLC analysis of NNSS2 using solvent methanol: water (70:30) and C18 column produced retention time of 5.8 min; (d) Spectral analysis of NNSS2 showed λ max of 287.2 nm; (e) MALDI–TOF of NNSS2 showed M.W of 882.6 D.

skin considered useful in reducing clouding of the cornea. In Indian traditional, folk and Santhal medicinal system mentioned the use of snake shed skin for reproductive disorders, and previous studies had shown that *Naja naja* shedded skin influenced rat

estrous cycle. However no reports are available regarding the presence of any bioactive compounds in the *N. naja* shedded skin. The present study was designed to isolate bioactive molecule from *N. naja* shedded skin and the probable molecular action on female estrous cycle.(Mukherjee 2016).

The *N. naja* shedded skin extract was subjected to thin layer chromatography, HPLC for purification to obtain active factor, and it was characterized (MALDI, CD spectral analysis, H1NMR & XRD). Purified fraction was injected subcutaneously in female Swiss albino mice. Serum progesterone, estradiol, IL-1ß, TNF-a levels were assessed; histopathology of uterus and ovary was done. Uterine and ovarian apoptotic marker expressions were studied. NNSS2 was purified having molecular weight of 882.6 Dalton. It caused cessation of estrous cycle for 5 days, decreased serum progesterone, P_4-E_2 ratio, increased IL-1ß, caspase 3,9, Bax, decreased BCL2, HSP70, HSP90 expressions and cleaved PARP. Histological studies of ovary showed immature follicles; and uterus displayed constricted structure. NNSS2 influenced reproductive cycle of female albino mice by altering hormones, cytokine profiles, apoptotic markers, and by involvement of intrinsic apoptotic pathway. This study provided a novel outline of the probable bioactive compounds present in the *N.naja* shedded skin.

This present study was designed to isolate a bioactive factor from *Naja naja* shedded skin. In the recent study, a small molecular weight crystalline peptide NNSS2 of 882.6

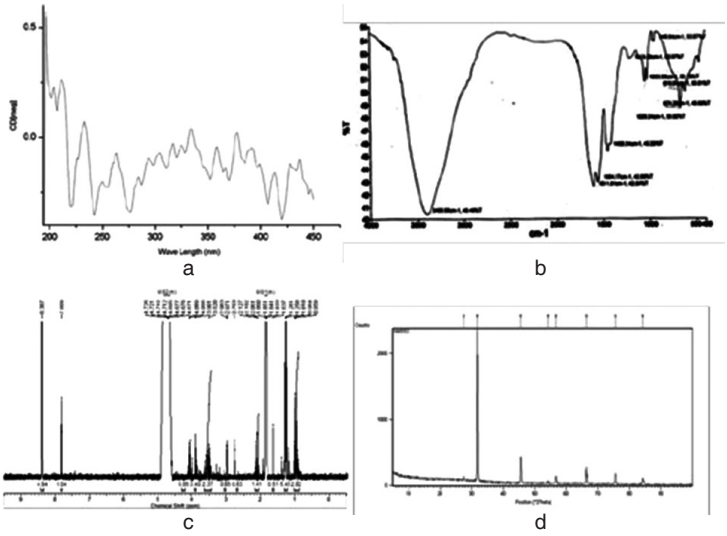


Fig. 2: Characterization of NNSS2. (a) CD spectral analysis of NNSS2; (b) FTIR analysis of NNSS2; (c) H1NMR of NNSS2; (d) XRD analysis of NNSS2.

Dalton was isolated from *Naja naja* shedded skin. CD spectral analysis indicated NNSS2 is composed of ß sheet random coils and a helix. NNSS2 is crystalline and is composed of ß-sheeted structure, N-H bonding, scissoring, bending and double bonds. Six amino acids had been identified so far namely asparagine, aspartate, glutamine, glycine, phenylalanine and tryptophan form. NNSS2 caused cessation of the estrous cycle at diestrous phase for five days when observed microscopically, with corresponding change in ovarian and uterine histology. NNSS2 caused loss of three distinct layers, uterine glands and luminal structure with formation of vacuolated structure

(Fig. 3B). NNSS2 produced constricted ovarian structure, follicular atresia, phase arrests, absence of granulosa cell lining (Figure 3D), indicating uterine and damage and may be the cause behind phase arrest. The histological findings of both ovary and uterus supported tissue damage suggesting anovulation and phase arrest at diestrous. Tissue damage that had taken place in the uterus and ovary might have occurred either by apoptosis or by necrosis. Hence, to further elucidate the death pathway, expression of intracellular apoptogenic proteins of ovarian and uterine tissues were studied. In both the ovary and uterus increased the expression of caspase 3 and caspase 9 and cleaved PARP with no change in caspase 8 activities indicated involvement of intrinsic apoptotic pathway. PARP cleavage by caspase 3 is a considerable marker for apoptosis [Mukherjee et al 2010]. In the present study NNSS2 caused PARP cleavage indicating apoptosis through caspase 3 dependent pathway. No significant change in TNF-a level further confirmed absence of extrinsic pathway as TNF-a receptor is responsible for the activation of caspase 8 through the death receptor complex. The intrinsic pathway of apoptosis gets activated by negative signal given by decreased level of progesterone and a positive signal from increasing expression of IL-1ß, eventually activated the caspase dependent pathway [Mukherjee 2016]. This mitochondrial dependent pathway is regulated by BCL2 family of proteins which included proapoptotic protein like Bax and antiapoptotic protein like BCL2 by modifying mitochondrial membrane permeability. NNSS2 increased expression of proapoptotic protein Bax and decreased the expression of antiapoptotic protein BCL2, ultimately leading to the activation of effector molecule caspase 3. Activation of caspase 3 leads to the proteolytic cleavage of PARP responsible for morphological and biochemical changes in apoptosis . NNSS2 caused anovulation hence it can lengthen a normal cycle by modulating the hormones, cytokines and intracellular apoptotic proteins. From the above findings it could be concluded that this study gave a novel insight into some of probable bioactive factors present in snake (*N. naja*) shedded skin which remained unexplored until now.

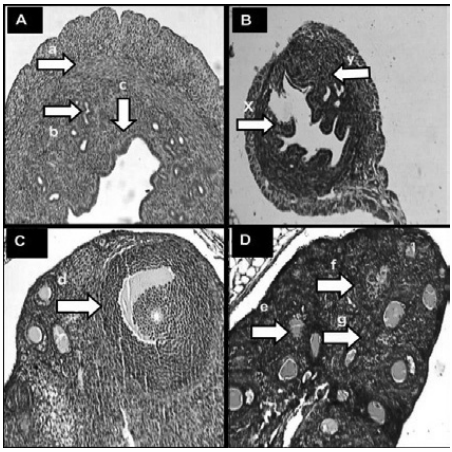


Fig. 3: Histopathological studies of NNSS2 treated ovary and uterus. Histological structure of control diestrous uterus (A) NNSS2 treated mice uterus (B) Histological structure of control diestrous ovary (C) NNSS2 treated ovary (D) Control diestrous uterus. a,b) presence of perimetrium, myometrium, endometrium, uterine glands c) Star shaped lumen. Control diestrous ovary d) follicles at different stage of development. NNSS2 treated uterus x) absence of uterine glands y) presence of vacuolated structure, NNSS2 treated ovary e) distorted follicle f) immature constricted follicle g) phase arrest of follicles. All the sections were stained with haematoxylin and eosin and magnification was 65X.

References

- S. Mukherjee, **S.C. Dasguptata**, A. Gomes. Estrous Cycle Cessation Caused via Activating the Apoptotic Pathway by NNSS2 Isolated from *Naja naja* Shedded Skin. J Toxins; 3(1): 3-7, 2016.

- Anti-osteoarthritic activity of *Bungarus fasciatus* venom fraction BF-F47 involving molecular markers in the rats. Antony Gomes, Susmita Ghosh, Sourav Ghosh, Kalyani Saha, Partha Pratim Saha, **Subir Chandra Dasgupta**, Aparna Gomes *Toxicon 118, 43-46*, 2016.
- Antinociceptive, anti-inflammatory antiarthritic activity of *Bungarus faciatus* venom in experimental animals. Indian Journal of Expt. Biology 54, 569-576, 2016.
- Susmita Ghosh, Kalyani Saha, **S. C. Dasgupt**a & A Gomes, "In vitro and in vivo anti-arthritic and anti-inflammatory activity of *Bungarus fasciatus* venom" Journal of Toxin, 2(1) 5-7, 2015.
- Sanghamitra Mukherjee, **Subir Chandra Dasgupta** & Antony Gomes, Effect of *Naja naja* Laurenti shed skin extract on estrus cycle, hormone-cytokine profile, histopathology of ovary & uterus of Swiss albino rats. Indian Journal of Experimental Biology, 51, 235-240 , 2013.
- Antony Gomes, Md. Aftab Alam, Sourav Bhattacharya, **Subir Chandra Dasgupta**, Sanghamitra Mukherjee, Shamik Bhattacharya, Aparna Gomes, Ethno biological usage of zoo products in rheumatoid arthritis, *Ind Jr Exp. Biol*. 49, 563-573, 2011.
- A Gomes, P Bhattacharjee, A K Biswas, **Subir Chandra Dasgupta**, B Giri, A Debnath, S Dasgupta, T Das & Aparna Gomes. Anticancer Potential of animal venom and toxins. *Ind Jr Exp. Biol.*, 48, 93-103, 2010.
- S. Halder, S. Dasgupta, A. Gomes, B. Giri, **S. C. Dasgupta**, A. Biswas, A. Mishra, A. Gomes, A high molecular weight protein Bengalin from the Indian black Scorpion *Heterometrus bengalensis* (C. L. Koch) venom having anti-osteoporosis activity in female albino rats. Toxicon 53(1) 60-68, 2009.
- Biplab Giri, Archita Saha, R. Mishra, **Subir C. Dasgupta**, A Debnath, Aparna Gomes, & Antony Gomes, Bioactive molecules from amphibian skin: Their biological activities with reference to therapeutic potentials for possible drug development, Indian Journal of Experimental Biology, 45, 579-593, 2007.
- D Muhuri, **S C Dasgupta** & A Gomes, Lethal oedema, haemorrhagic activity of spotted butterfish (*Scatophagus argus*) sting extract and its neutralization by aniserum and pharmacological antagonist. Indian Journal of Experimental Biology, 43, 493-497, 2005.
- D. Muhuri, S. Karmakar, **S. C. Dasgupta**, A K Nagchaudhuri & A Gomes, Pharmacological studies on the venomous spotted butterfish (*Scatophagus argus*, Linn) sting extract on experimental animals. Indian Journal of Experimental Biology Vol. 42, 461-467, 2004.
- S. Karmakar, D. C. Muhuri, **S. C. Dasgupta**, A. K. Nagchaudhuri & A Gomes, Isolation of a haemorrhagic protein toxin (SA-HT) from the Indian venomous butterfish (*Scatophagus argus,* Linn) sting extract, Indian Journal of Experimental Biology Vol. 42,. 452-460 , 2004.
- Manika Das, **S C Dasgupta** & A Gomes, Isolation, purification and partial chemical characterization of a lethal factor from common Indian toad (*Bufo melanostictus* schneider) skin extract. Indian Journal of Experimental Biology, 39, 781-785, 2001.
- A Gomes, Manika Das, M I Alam & **S C Dasgupta**, Bidder's organ extract induced anaphylaxis in experimental animals. Indian Journal of Experimental biology, 38, 177-179, 2000.
- Manika Das, B N Mallick, **S C Dasgupta** & A Gomes, A sleep inducing factor from the common Indian Toad (*Bufo melanostictus*) skin extract, *Toxicon*, 38, 1267-1281, 2000.
- A Gomes, M I Alam, D C Muhuri, B Auddy & **S C Dasgupta**, A lethal Cardiotoxic protein isolated from the Bidder's organ of the common Indian Toad (*Bufo melanostictus* schneider). Indian Journal of Experimental Biology, 34, 211-215 , 1996.
- A Gomes, M I Alam, B Auddy & **S C Dasgupta**, Isolation purification and partial characterization of a haemolytic protein from the Bidder's organ of the toad *Bufo melanostictus* (Schneider). Indian Journal of Experimental Biology, 32, 119-123, 1994.

150th
Birth Anniversary
Celebration

PUBLIC WATER SUPPLY : ISSUES & CHALLENGES

Prof. Arunabha Majumder
Professor-Emeritus, School of Water Resources Engineering,
Jadavpur University & Former Director-Professor,
All India Institute of Hygiene & Public Health.;
E-mail : arunabhamajumder@hotmail.com

Water is a natural resource but renewable through cyclic process of the climate. Water is essential for our life, livelihood, food security and sustainable development. Though water is available plenty in nature, but availability of fresh water is limited. India having 16.7% of world population and 2.4% of world's land area is to satisfy with only 4% of world's fresh water resources. The per capita availability of water is decreasing in the country and it has reduced today to one-third compared to water availability during 1947. The demand of water is increasing at a faster rate due to growing population, agriculture, food production, industrialization and economic development. Again climate change in recent time has resulted in alteration of rainfall pattern. It has been predicted that the climate change is likely to increase the variability of water resources affecting livelihood and human health. Spatial rainfall pattern of varying characteristic has resulted in uneven water resources and thereby developing water stress and water-scarce situation in many regions of the country. The situation has aggravated due to natural and anthropogenic pollution of both groundwater and surface water sources.

The global water cycle is deeply embedded in the earth system and thus strongly related to water resources and human development. Global temperature rise vis-à-vis climate change will cause considerable fluctuation in the hydrological cycle. While the amount of water may remain the same the probability of extremes, such as, frequent flooding and droughts are likely to be more as well as severe than before. This situation may cause adverse impact on agricultural and industrial development. The global warming and climate change will result in decrease flow in rivers, deterioration of water quality through increased pollutant concentrations and load from surface run-off and overflows of water facilities.

According to national water policy (2012), planning, development and management of water resources need to be governed by common integrated perspective considering local, regional, state and national context, having an environmentally sound basis, keeping in view the human, social and economic needs as well as good governance through transparent informed decision making to achieve equity, social justice and sustainability. Unplanned and uncared abstraction of ground water in many regions has resulted in scarcity of fresh water with depletion of ground water table and deterioration in water quality.

ISBN : 978-81-933395-0-3

Water is a public good and every person has the right to demand drinking water. To increase economic productivity and improve public health, there is an urgent need to enhance access to safe and adequate drinking water. Accordingly every water supply agency must ensure water security and safety for the consumers addressing the issue of potability, reliability, sustainability, convenience and equity.

The quality of groundwater in certain regions has undergone a change to such an extent that the use of such water could be risky and hazardous. Increase in overall salinity of the groundwater and / or presence of high concentration of fluoride, arsenic, iron, nitrate, total hardness and few toxic metals have been noticed in large areas of several states in India. Drinking of fluoride (Acceptable limit: 1.0 mg/l; Permissible limit: 1.5 mg/l) contaminated water may cause dental, skeletal and non-skeletal fluorosis. Excess fluoride in groundwater has been detected in more than 200 districts in 20 states of the country. People may suffer from arsenicosis if drink arsenic contaminated groundwater (Acceptable limit: 0.01 mg/l; Permissible limit: 0.05 mg/l) for prolong period. Arsenic contamination in groundwater has been detected in West Bengal, Bihar, Uttar Pradesh, Jharkhand, Chattisgarh, Assam and Manipur. Nitrate contamination (Acceptable and Permissible limit: 45 mg/l) in groundwater has been detected in certain parts of the country. Drinking of nitrate contaminated water may cause 'Blue Baby' disease among new-born babies. Coastal regions of the country are suffering from fresh water crisis due to saline water intrusion. Over-abstraction of groundwater is resulting in higher concentration of total dissolved solids in many regions of our country. Bacteriological contamination of groundwater is also getting reported during water quality monitoring.

Quality of surface water sources are getting deteriorated due to mixing of untreated or partially treated municipal sewage and industrial effluent. Surface and groundwater pollution from pesticides, insecticides, toxic chemicals and heavy metals are causing problem and concern in many places. Bacteriological contamination in many rivers, lakes and other water bodies has reached to alarming proportion. If this situation continues and action to control pollution is not taken up immediately then it will be difficult to purify river water by the application of conventional water treatment process.

Public water supply qualitatively must conform to the specification laid down by Bureau of Indian Standard (10500: 2012). Thus any unwanted matters or impurities need to be removed from surface water and ground water by using appropriate water treatment process. Unit operations of water treatment process may be sedimentation, co-precipitation, filtration, adsorption, ion-exchange, disinfection etc. Finer and dissolve impurities can be removed by the application of micro-filtration, ultra-filtration, nano-filtration and reverse osmosis. In order to keep water pathogen free disinfection is mandatory. Point-of-use water purifiers have been developed by various manufactures using different technologies suitable for separation of target impurities. Such water purifiers mostly use U-V rays for disinfection. Package drinking water and mineral water manufactures prefer ozonization and U-V rays for disinfection.

In order to assure safe water supply to the consumers there must be water quality monitoring and surveillance program. Water quality can be assessed by testing in the laboratory or by using field test kits on regular basis. Surveillance of drinking water quality is an uninterrupted and vigilant public health assessment and watchdog of

drinking water supplies. Water testing laboratory infrastructure alongwith field testing kit should be available for both urban and rural water supply systems. Ministry of Drinking Water and Sanitation is extending support to all State Governments to carry out Water Quality Monitoring and Surveillance Program for rural water supply. State / District / Block level laboratories have been set-up for regular water testing. However, surveillance on water supply systems is yet to be introduced mostly in the States. The water quality reports of water supply system (at consumer point) must be available in public domain (at Gram Panchayet level).

In order to achieve water security at the individual household level, the water supply system should not depend on a single source. During natural calamity or pollution of different sources, the single drinking water source may either become non-potable or inaccessible resulting in acute shortage of drinking water availability to many, especially to the marginalized people and cattle. Water security involves conservation and storage of water by utilizing different sources for different use. It can be achieved by collecting and storing rainwater, treating surface water / groundwater for drinking and cooking, untreated water but of acceptable quality for bating and washing and grey water / spent water for flushing of toilets. To ensure risk and vulnerability reduction on such occasions and to ensure reliability and sustainability, a good framework should consider different drinking water sources accessible in different situation and different point of time.

Considering the actual problems of water scarcity that many parts of the country are facing and many parts are likely to face in near future, it would be prudent not to ignore the direct exploitation of nature's simplest and most fundamental source of renewable fresh water – Rainwater. Harvesting of rainwater is an assuring, ensuring and enduring way to make the nation capable to solve the water crisis. It is a technology that people can develop, use and manage; and therefore RWH must be popularized as people's program.

It is of great concern that low consciousness about scarcity of water and its life-sustaining and economic value has resulted in mismanagement, wastage and inefficient use of water. The un-accounted for water (UFW) in cities and towns ranges between 32 and 42% in our country. Similarly wastage of water in agriculture sector is extremely high. Thus wastage of water must be reduced by minimizing pipe leakages, judicious use of water in agriculture and industry. Recycling and reuse of water should be practiced in industries, multistoried buildings, institutional and commercial establishments. In water scarcity areas, water-shed management system may be adopted for augmentation of groundwater and surface water resources.

Water conservation is defined as the minimization of loss or waste, care and protection and appropriate use of water. Facilities are to be created for rainwater collection and storage through de-centralized and centralized approaches. Artificial recharging can be made mandatory through introduction or modification of building rules and regulations. More emphasis needs to be given on conjunctive use of surface and groundwater resources if feasible, to meet the water demand. Public water supply system may be operated with minimum prescribed loss. Installation of water meters and introduction of water-tariff may minimize considerable quantum of water loss from cities and towns. Application of appropriate water saving technology and appropriate cropping system may minimize water requirement in agriculture. Principle of recycling

and reuse of water may help in the process of water conservation so as to overcome the problem of water crisis.

Waste water treatment and management for abatement of pollution needs priority at the present juncture. Appropriate technology must be applied for treatment of municipal waste water. Emphasis must be given on tertiary treatment of waste water for reclamation of water. Water reclamation is a process by which waste water quality is upgraded by using biological and chemical treatment processes so that water can be returned to the environment safely to augment the natural systems from which it came. Most of the uses of water reclamation are non-potable uses such as, washing cars, flushing toilets, cooling towers for power plants, concrete mixing, gardening and irrigation etc. In order to minimize fresh water demand, industries must be motivated for recycling treated effluent in the process and if feasible, to achieve "zero discharge" credit.

Water is a State subject and State Government / its agencies are responsible for managing safe drinking water. With 73rd Amendment of the Constitution, rural drinking water has been placed in the XIth schedule of the Constitution to be devolved to Panchayeti Raj Institutions. The rural water supply program aims at empowered, well aware and skilled stakeholders capable of proper planning, implementation, operation, maintenance and management of water supply and water resources at all levels. A well planned information, education and communication (IEC) strategy is a necessity to play a critical role. IEC campaign has to inform, educate and persuade people to realize their roles and responsibilities, and benefits accruing from investing in right practices. Appropriate IEC strategy is needed to help the PRIs and rural community to take over the responsibility of managing and providing safe drinking water to all on a sustainable basis.

All water supply agencies must adopt holistic approach for facilitating water safety, security and sustainability. Following focused areas need to be addressed for ensuring water supply to rural and urban communities:

- ❒ Protection of drinking water sources; sustainability of water sources
- ❒ Planning and management of water services
- ❒ Use of safe and clean water
- ❒ Judicious use of water
- ❒ Avoiding wastage of water
- ❒ Rainwater harvesting, use and recharging
- ❒ Reuse and recycling of water; reclamation of water
- ❒ Water-borne diseases and illness time
- ❒ Water storage and handling
- ❒ Hygiene behavior and practice
- ❒ Water quality monitoring and surveillance
- ❒ Gender specific water issues
- ❒ Water pollution and control
- ❒ Water treatment; low-cost technology options
- ❒ Water safety and security
- ❒ Research and development study
- ❒ Community awareness and motivation / community involvement
- ❒ Implementation of 24 x 7 water supply where feasible
- ❒ Capacity building and institutional development
- ❒ PRI / community involvement in O&M of rural water supply system

150th
Birth Anniversary
Celebration

SIZE MATTERS: GLIMPSES OF SOME EXPERIMENTS WITH SILICON AND NOBLE METAL NANOPARTICLES

Mallar Ray
Dr. M. N. Dastur School of Materials Science and Engineering,
Indian Institute of Engineering Science and Technology,
Shibpur, Howrah: 711103, India
Email: mray@matsc.iiests.ac.in,
Phone: +91-33-2668-8140

Abstract
Nanoscience – the science of small objects, deals with size dependent material properties. Properties which are independent of size in the bulk form become size dependent when one or more dimension of any material is reduced below some critical size. This size is found to fall in the nanometric regime. Thus, when particle size is reduced to the nanoscale, properties such as melting point, fluorescence, electrical/thermal conductivity, permeability, and chemical reactivity change as a function of the size of the particle. However, the size at which a particular material property starts showing significant or measurable size dependence is not unique for all materials. Also, for the same material different properties start demonstrating size dependence at different sizes. As the physical dimensions of any particle approaches the nanometre scale, quantization and surface effects begin to play important roles, leading to drastic changes in measured properties. In addition to size — shape, defect and defect distribution, surface termination, and surroundings play important roles in determining the properties of nanostructured materials. To understand some of the fundamental features of nanostructures, two case studies are presented – light emission from Si nanocrystals and plasmon resonance in noble metal nanoparticles.
Keywords*:* Nano; size; property; luminescence; Plasmon

Introduction

Size dependent properties of materials have attracted much attention during the last thirty years.[1] There are evidences from the time of ancient civilizations that material properties were drastically changed by reducing size. For example, the Lycurgus cup, preserved in the British Museum is an artefact made by the Romans in the 4th century AD, which uses Au nanoparticles to render attractive colour. Wootz steel used to make some of the sharpest swords – the so called Damascus swords, dates back as far as 900 AD, has a microstructure of nanometre-sized tubes.[2] It is difficult to believe that the reasons behind such fascinating behaviour and precise control of properties as a function of size were known at that point in time. It is only during the later part of the last century that the scientists started investigating systematically the effect of size reduction on fundamental material properties. In the last thirty years or so, a significant amount

ISBN : 978-81-933395-0-3

of work has been directed in understanding the size dependent properties of different materials both in terms of actual experiments as well as fundamental theoretical studies. It has so far been revealed that material properties start showing size dependence when at least one of its dimensions is in the regime of 1-100 nanometres. Different properties show size dependence at different length scales for the same material. For example, Au nanoparticles can exhibit red or blue coloration due to surface plasmon resonance when the average crystal size is 50 nm or less. But they become luminescent only when their sizes are less than 2 nm.[3] Similarly, a given material property shows size dependence at different lengths for different materials. Both Si and compound semiconductors like CdSe, CdS, etc. become luminescent when they are reduced to the nanoscale. But the sizes at which they start emitting light are different and depend on the material under investigation.

Incidentally, the scale at which the so-called intrinsic material properties like, conductivity, refractive index, elastic moduli, susceptibility, melting or boiling point, etc. starts becoming size dependent, falls in the nanoscale. This is not unexpected. At this length scale there are countable numbers (10^2 to 10^7) of atoms or molecules in a single cluster of the material. Consequently, most of the materials properties are dominantly determined by the surface effects as the number of atoms or molecules residing on the surface of such clusters are reasonably high. The enormous surface to volume ratio of nanostructured materials is perhaps the key factor in deciding the exciting size dependent properties. The fraction of atoms on the surface of a spherical particle (P, percentage) varies with the total number of atoms, N, as: $P \approx 4N^{-1/3} \times 100$ and for a cube this percentage is: $P \approx 6N^{-1/3} \times 100$.[4] Therefore, for typical metals or semiconductors, the fraction of atoms residing on the surface becomes comparable with the number of atoms in the core when the size is less than 100 nm. This very aspect also brings in the question of shape. When same number of atoms are placed together to form clusters of different shapes, the fraction residing on surface are naturally dependent on shape. The ratio obviously is the least when the shape is spherically symmetric. Consequently, shape along with size plays a role in shaping the properties of nanomaterials.

For a given shape and size, defects and defect distribution in naomaterials play vital roles in determining their overall behaviour. It is well known that presence of defects of various kinds influences the characteristics of materials in their bulk form. In the nanoscale, where we deal with countable number of atoms, the role of defects is even more significant. The absence of atoms in the form of point defects or line defects can have major effect on the material properties. It is therefore, important to understand defects and their distribution in understanding nanomaterials.

Apart from size, shape and defects, surface configuration of nanomaterials plays an extremely important role. We know that a nanomaterial is characterized by a large surface area compared to the volume. When we make such a statement we usually refer to the physical largeness of the surface. It is not only the magnitude of this surface but also its character (configuration and composition), which largely determines the behaviour of a nanosystem. Usually, the surface of a nanostructure is protected or capped by some material. This capping agent may significantly influence the property. Also, it has been seen that presence or absence of some moiety on the surface, or the

presence or absence of stoichiometry, or, even the presence or absence of unsaturated surface bonds may affect the behaviour of a nanomaterial. Hence, the surface of a nanomaterial is important for more reasons than one.

Quantum size effects

One of the direct effects of reducing the size of materials to the nanometre range is the appearance of quantum effects due to the confinement of the movement of electrons. We know that electrons can behave both as particles as well as waves. As waves they are free to move in the entire space bounded by some high potential beyond which they can move only if supplied with some energy greater than the potential. Although there is a finite probability of tunnelling through potential barriers. This probability is very low and may be ignored for this discussion. In clusters of gases and liquids electrons remain confined to atoms or molecules. Such clusters do not show quantum size effects beyond the ones which they show in isolated atoms or molecules. In semiconductors and metals the conduction electrons are free to move in the entire cluster and the electron waves adapt to the size in such a way that the nodes of the waves are at the surface. Therefore, when sizes of the clusters are reduced, the maximum wavelength to be excited and accommodated inside the clusters decrease. This leads to discretization of energy levels of the delocalized electrons depending on the size of the structure. Consequently, semiconductor and metal nanoparticles exhibit quantum size effects.

Another requirement that comes from quantum mechanics is Pauli's exclusion principle. As electrons fill up the discrete energy states formed as a result of quantization, it does so exactly in the same way as in atoms as we move through the periodic table. Therefore, electron energy jumps when a new series of levels starts to be occupied. Hence, quantum size effects lead to non-continuous size scaling behaviour. In fact the behaviour of small clusters is so similar to that of atoms that they are often regarded as pseudo-atoms or super-atoms.

Classical size effects

Size effects observed in nanoparticles are not necessarily due to quantum mechanical effects. Many of the size dependent properties of materials can be explained classically. For example, decrease in crystal size leads to increase in surface energy which consequently decreases melting point. This is simply because surface atoms require less energy to move as they are in contact with fewer atoms of the substance. Changes in the grain size result in a high density of incoherent interfaces or other lattice defects such as dislocations, vacancies, etc. As the grain size of a solid decrease, the proportion of atoms located at or near grain boundaries relative to those within the interior of a crystalline grain, scales as 1/size. This has important implications for properties in ultra-finegrained materials which will then be principally controlled by interfacial properties rather than those of the bulk. The bright attractive colouration of Au and Ag nanoparticles colloids can also be largely explained classically. The resonance of oscillating surface plasmons inside Au or Ag nanoparticles with that of an external electromagnetic radiation, results in sharp rise in absorption of the resonant wavelength which in turn produces the colour of these nanoparticles colloids. This phenomenon is well explained within the realms of Maxwell's theory.

In this article we shall now present two case studies involving light emission from Si nanocrystals and plasmon resonance in Au nanoparticles where quantum and classical size effects manifest to endow these nanomaterials with fascinating properties.

Light emission from Si nanocrystals

Despite all its success as an electronic material, Si has one major disadvantage – that it is an indirect band gap material which makes it a poor light emitter. Photon emission originates from low-probability, phonon-mediated transitions that compete unfavorably with fast, non-radiative de-excitation paths, such as Auger recombination and free carrier absorption.[5] Whereas the III-V semiconductors are direct band gap materials and thus preferred for photonic applications. However, integration of these compound semiconductors in the prevailing Si based circuits is a major problem as they are not compatible with Si IC processing technology. At present the only viable technology for on-chip light source is a hybrid system where integration is done by bonding a III-V layer on top of Si. All the efforts of heterogrowth of III-V on Si have so far been unsuccessful.[6] Hence the need to develop Si based stable light sources that can be easily integrated with standard microelectronics based on crystalline Si, still remains a pertinent and challenging problem. Photoluminescence (PL) from quantum structures, in particular from indirect band gap material — Si, has therefore been a key area of investigation due to its prospective application in opto-electronic devices as a solid light emitter.[7]

Preparation

Commercial Si powder, with average particle size 20 μm (Alfa Aesar), with nominal purity of 99.9% was used as the starting material. Mechanical milling of the sample was performed in a Fritsch P6 planetary ball mill. The ball mill was operated at 250 rpm with a ball-to-powder weight ratio of 10:1, using WC vial (250 mL) and balls (10 mm). Toluene was used as the milling medium to minimize oxidation and agglomeration. Milled powders were taken out after 25 h, 50 h, 75 h and 100 h respectively and were transferred in clean and covered petri dishes and allowed to dry for 3 weeks in a glove box in nitrogen environment. A standard Piranha etch of the dried powder with 2:1 solution of H_2SO_4 (98%) and H_2O_2 (30%) was carried out to remove any trace organic and metallic contaminants. The solution of Si powder (approximately 0.5 gm) in H_2SO_4 and H_2O_2 solution (5 mL) was then slowly heated at around 110°C till the entire liquid evaporated and dry deposits of oxygen rich Si nanocrystals was obtained. The heating was carried out in ambient atmosphere inside a fume hood to promote sufficient oxidation. Subsequently, the particles were dissolved in ethyl alcohol and sonicated to prepare colloidal suspension of particles made of Si nanocrystal core surrounded by an amorphous silicon oxide shell.

In an attempt to obtain smaller Si nanocrystals and to etch the oxide shell, reactive ion etching (RIE) in CF_4/O_2 plasma was carried out. RIE system used here is an STS 310 with a 13.56 MHz RF source. Prior to the etching of Si-Si oxide nanostructures in CF_4 plasma, an O_2 plasma clean of the RIE chamber was carried out for 30 min to remove any trace contaminants. The powder samples of the Si nanocrystals prepared by forced oxidation of milled Si were spread over a clean electropolished Si wafer.

However, simple spreading of the powders caused a major problem as the agglomerated Si nanocrystals in the oxide piled up to form large aggregates thereby masking most of the samples from plasma exposure during the etch process. In an attempt to overcome the problem, heavily loaded colloids of the powders were formed in isopropanol. These suspensions were thoroughly ultrasonicated to break the agglomerates and the wafer substrates were dip coated to obtain a deposition of a thin layer. Isopropanol was subsequently evaporated in a fume hood under ambient conditions. The process did not ensure helped in maximizing the exposed surface area of the oxide covered nanocrystals to the plasma.

The initial RIE parameters were chosen from previously reported work and theoretical simulation studies reported earlier.[8] In an attempt to obtain the desired results the chamber pressure, RF power and etching time were varied and the final etching was performed with the following parameters: RF power = 200 Watt, chamber pressure = 315 mTorr, CF_4 flow rate = 40 sccm, O_2 flow rate = 2 sccm, etch time 2 min. A second batch of samples was prepared by treating the core/shell nanostructures in 10% buffered aqueous HF. About 0.5 mg of the powder was immersed in 10 ml of HF in teflon bath and was kept inside a fume hood for slow evaporation. Addition of HF initiated visible reaction associated with the formation of bubbles. After the reactions subsided, the solution was slowly heated at ~70°C till dry deposits of HF treated Si nanocrystals were obtained. Colloidal suspensions of these dry powders were formed by sonication and centrifugation.

Structural properties

X-ray diffraction studies

X-ray diffraction studies (XRD), atomic force microscopy (AFM) and transmission electron microscopy (TEM) are three major characterization techniques that allow

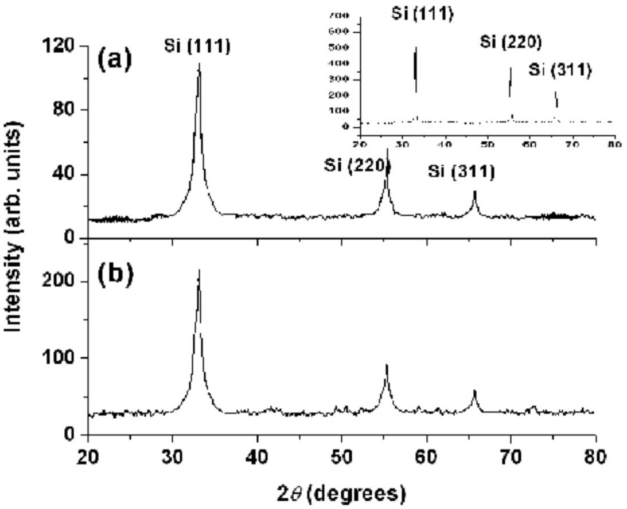


Fig. 1: XRD profile of Si-SiO_2 core-shell nanocrystals, (a) 2 min RIE treated samples in CF_4/O_2 plasma, and (b) 10% buffered HF etched samples. Inset is the XRD prior to etching of the 100 h ball milled and oxidized sample. The different planes of Si are indexed according to JCPDS card: 27-1402.

investigation of nanocrystals. Nanocrystals are characterized by broad Bragg diffraction peak in the XRD profile as shown in Fig. 1. Appreciable broadening of the Bragg diffracted peaks after etching the core/shell nanostructures is evident. Comparing with the XRD of the samples before the etch processes (shown as inset), it is clear that both CF_4/O_2 plasma and HF treatment is able to form Si nanocrystals with much smaller size.

Two notable features are apparent from the XRD profile. First, no detectable peak of SiO_2 or any other peaks (from contaminants etc.) are present. Though this does not eliminate the possibility of existence of trace contaminants, it may be inferred that milling in a planetary ball mill does not introduce any substantial contamination as has been previously reported by Shen et al.[9] who observed visible PL from milled Si nanocrystals containing detectable peaks of iron in the XRD spectrum. Secondly, no resolvable hump in the spectrum due to amorphous SiO_2 component is present indicating relatively small amounts of amorphous phase.

Atomic Force Microscopy

Topographic and phase contrast AFM images of the Si nanocrystal/SiO_2 system, formed after chemical and thermal oxidation, were recorded to study the general particle features and to differentiate between the c-Si and the corresponding oxide phases respectively. It is clear from Fig. 2, which shows the topographic image of the particles, that there is significant dispersion in the particle size. The size segregation indicated in Fig. 2 was achieved through repeated sonication and centrifugation. However, the estimated size (~10 nm) indicated in Fig. 2 is that of a composite particle made of crystalline Si core surrounded by an oxide shell, which is evident from the phase contrast image shown in Fig. 3 (a) and (b). All the particles seen in the phase contrast image consists of a darker core surrounded by an annular brighter region representative of core-shell structures.

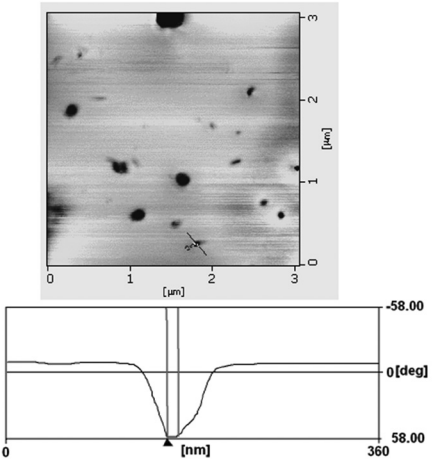


Fig. 2: Topographic AFM image of the chemically and thermally treated ball-milled Si (75 h milled) and the corresponding line profile analyses. The size of the particle indicated in the figure is estimated to be 10.5 nm from the line profile as indicated by the red lined.

Phase imaging provides a map of stiffness variation on the sample surface such that a stiffer region appears brighter thereby providing a means for differentiating phases with different elastic moduli.[10] Later works have shown that phase contrast, in many cases, is independent of variations in the elastic moduli, particularly when the energy used in surface deformation is elastically recovered.[11] Recent works attribute contrast variations with the changes in viscoelasticity.[12] However, in this case it may be asserted that, whatever be the reason of contrast variation, the image shown in Figures 3 (a) and (b) clearly reveals the existence of two distinct phases forming spherical core-shell structures. That the darker core is

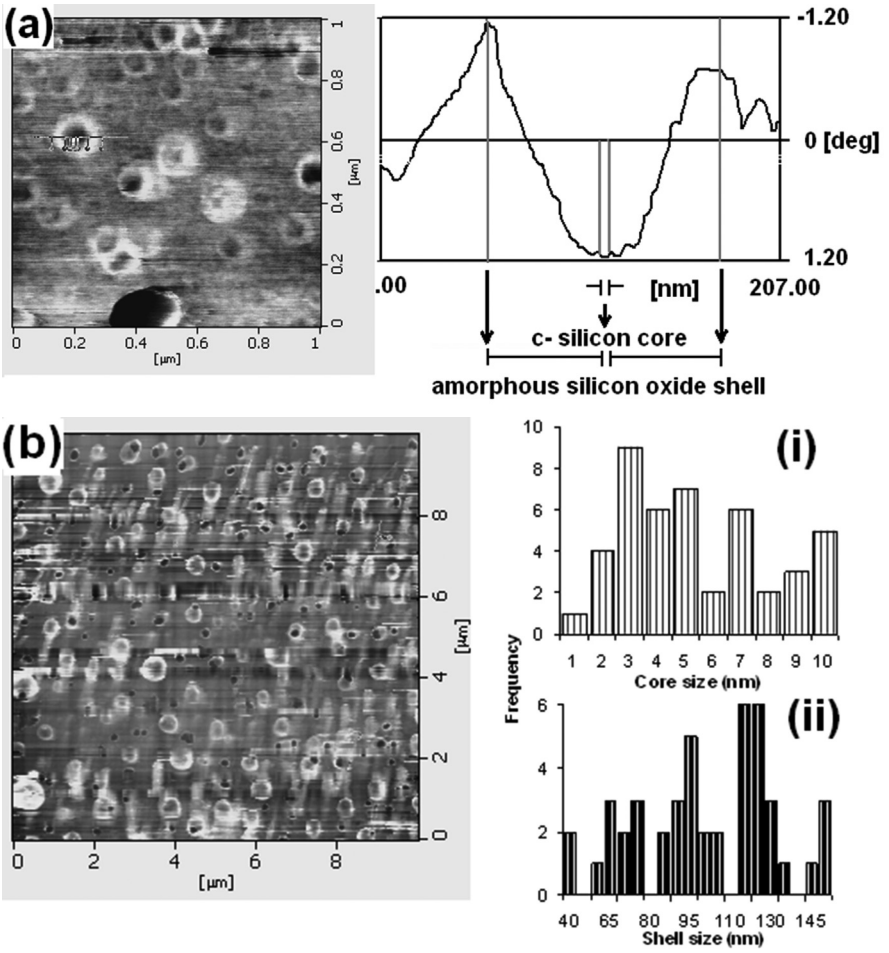


Fig. 3: Phase contrast AFM images of the treated ball-milled (75 h) Si showing the presence of spherical core-shell structures with the darker region representing crystalline Si core surrounded by a brighter zone of silicon oxide. Particles with varying core and shell sizes are decipherable. (a) AFM micrograph along with the line profile analysis of the marked particle, which reveals a core diameter of ~7 nm and a shell thickness of about 90 nm; and (b) an AFM image capturing more than 50 spherical core shell particles. The histograms (i) and (ii) show that the sizes of the crystalline Si core vary from 1 to 10 nm. The shell sizes are found to have much greater size dispersion (40 to 145 nm). The histograms are constructed by measuring the core and shell sizes from individual line profiles of 50 particles identifiable in the AFM image.

crystalline Si is verified by the TEM images (discussed later). The brighter shell is amorphous Si oxide formed by the forced oxidation of the milled Si nanocrystal with perceptible strain concentrations at the extended and diffused interface.

The estimation of the core and shell dimensions of each particle identifiable in Figures 3 was done from the line profile analysis. The zero slope region, *i.e*. the region over which there is no variation of elastic/viscoelastic property is assumed to be the pure crystalline Si core. Core sizes estimated in this manner are found to vary between

1 to 10 nm and hence agree well with the TEM results. It is evident from the line profiles that the slopes on either side of the crystalline core are not exactly identical, indicating the following: (i) the amorphous shell is not evenly spread around a core, (also clear from visible inspection of the AFM image); (ii) there is an extended diffused boundary between the crystalline and the amorphous phases – a feature attributed to forced invasive oxidation; (iii) the presence of small 'kinks' and tiny 'plateaus' in the gradually varying hump are suggestive of strain concentrations mainly at the interface of the crystalline and the amorphous phases. It may be noted that the tendency of coalescence of two or more particles (core-shell structures) to form agglomerates is also apparent from Figure 3 (a).

Transmission Electron Microscopy:

Figures 4 (a), (b), (c) and (d) show some of the representative high resolution (HR)-TEM images of the chemically oxidized Si nanocrystals after 75 h milling. The synthesized clear suspension of Si nanocrystals upon evaporation on a TEM grid forms extended agglomerates having an appearance of crystalline islands in amorphous background. The bright field HR-TEM image represented in Figure 4 (a) shows the presence of Si nanocrystals which appear as dark spots. The inset is the corresponding selected area electron diffraction pattern (SAEDP). The SADP clearly shows rings of Si and the corresponding planes are (111), (220) and (311). The (331) plane is also visible

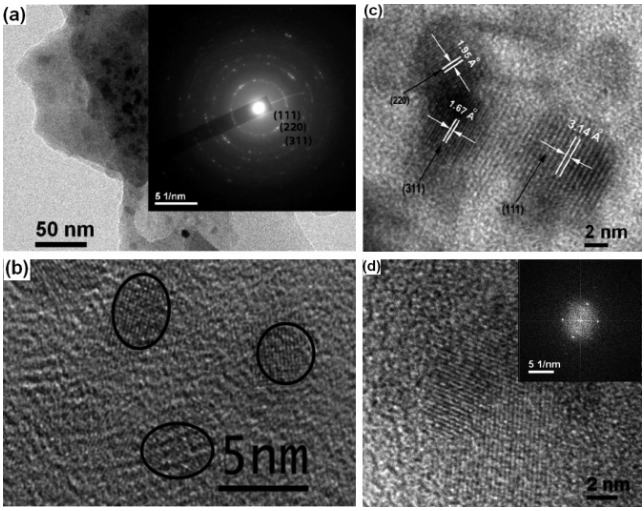


Fig. 4: HR-TEM images of chemically oxidized, ball-milled Si. (a) Bright field image of the sample powder dispersed in copper grid. Inset shows the corresponding SAED pattern; (b) near surface image showing presence of Si nanocrystals with dimensions < 5 nm, embedded in amorphous background; (c) nanocrystalline Si islands consisting of all the 3 planes identified by XRD shown in Figure 1; (d) near surface image showing random orientation of neighboring crystallites. The inset is the corresponding FFT image.

(not marked). The nearly continuous rings are suggestive of random orientation of the neighboring crystallites. It is clear from the Figure 4 (b) that Si nanocrystals with sizes < 5 nm are present and embedded in an amorphous background. In this image the

volume fraction of amorphous Si appears to be higher compared to the crystalline phase indicating that distribution of amorphous and crystalline phases is not homogeneous in the sample. The core-shell structure is not quite decipherable here because of possible agglomeration and relative abundance of amorphous component. The Si (111), (220) and the (311) lattice fringes are all clearly detectable from Figure 4 (c). The dark region at the interface of the (220) and the (311) planes suggests development of strain at the nanocrystal boundaries due to lattice mismatch. This figure also verifies the random orientation of the different neighboring crystallites. This is further verified by a closer near surface view of the sample shown in Figure 4 (d) that reveals two differently oriented Si nanocrystals separated by a dislocation boundary and surrounded by amorphous component. The inset is the corresponding FFT. The clear spots and diffused background in FFT image is indicative of lattice strains inside the crystallite. We believe that the strains in the crystalline regions are developed due to invasive oxidation during chemical and thermal treatment of the milled Si.

The HR-TEM images of the RIE and HF etched samples are shown in Figures 5 (a)-(f) which were taken shortly (within 24 h) after the etchings were performed to minimize the effect of ambient oxidation. The micrographs shown in Figures 5 (a)-(c) are those of the RIE etched samples and those in Figures 5 (d)-(f) are of the samples etched in 10% buffered HF. The TEM images suggest the following: (i) CF_4/O_2 plasma has etched Si in addition to the oxide, thereby introducing a further step of size reduction, and Si etching increases with time as evident on comparison of Figures 5 (a) and (b). It is difficult to infer from the low magnification image, Figure 5 (a), whether the low-contrast diffused spots appear as a consequence of variation in focus setting due to randomly oriented Si nanocrystals or represent the oxide phase. (ii) Although it appears from Figures 5 (a) and (b), that the nanocrystals are more-or-less spherical, high magnification image shown in Figure 5 (c) shows the non-spherical nature of a nanocrystal (aspect ratio ~1.4). This is indicative that RIE has affected a non isotropic etching of Si. (iii) HF etching too, has apparently produced smaller Si nanocrystals as shown in Figure 5 (d) and the thick oxide shell of the core/shell structures has been successfully etched. (iv) Figures 5 (e) and (f) clearly represent formation of isolated, spherical, free-standing Si nanocrystals with no detectable oxide shell. However it is difficult to exclude the presence of any thin oxide layer surrounding the nanocrystals which is necessary to saturate the dangling bonds on the surface. (iv) The nearly continuous rings in the SAED patterns shown as insets in Figures 5 (a), (b) and (d) are suggestive of random orientation of the neighboring crystallites and the diffused halo indicates an amorphous background which may be due to the presence of either amorphous Si or Si oxide.

Since TEM images cannot give representative dimensions and shapes in the absence of large statistical data, we do not claim that either of the etching processes has produced uniform structures, but based on the agreement of the TEM data and other characteristics, some general assertions can be made. First, it may be inferred that both RIE and HF etch has successfully etched the thick oxide shell. Second, TEM images suggest that HF etch is more effective in forming isolated, spherically symmetric nanocrystals whereas RIE affects anisotropic etching. The purpose of presenting two similar micrographs in Figures 2 (e) and (f) representing identical shapes and sizes is to establish that formation of free-standing spherical quantum dots of Si with diameter

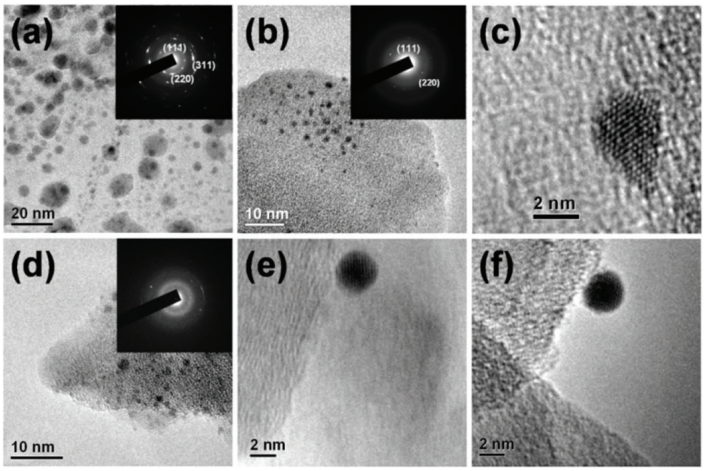


Fig. 5: HR-TEM images of dry and wet etched core/shell Si/Si-oxide nanostructures. (a)-(c) represent samples etched in CF_4/O_2 plasma with RF power 200 W and chamber pressure 315 mTorr, and (d)-(f) are images of samples etched in 10% buffered aqueous HF. (a) Bright field image after 1 min etching showing particles with sizes varying from ~5-15 nm. The inset is the corresponding SAED pattern. The (111), (220) and (311) planes are clearly identifiable. (b) Image of the sample after 2 min etching with the same parameters showing even smaller crystallites. The diameters of the particles captured in the image vary from ~1-3 nm. The SAED pattern shown in the inset depicts blurred spots with diffused rings and a halo, typical of very small crystals. (c) An isolated non-spherical Si nanocrystal with almost no detectable oxide shell, located in the 2 min etched sample. (e) Low magnification image of HF etched sample showing particles with size varying from ~1-5 nm. The inset is the SAED pattern typical of Si nanocrystals as shown before. (e) and (f) Isolated, spherical, free-standing quantum dots present in the HF treated sample with diameter ~2 nm.

~2 nm is not a single event captured in one out of the many images taken. Third, RIE produces Si nanocrystals with smaller average dimensions compared to HF, and this is supported by XRD data.

Luminescent characteristics

The colloidal suspensions of oxidized Si nanocrystals exhibits intense room temperature luminescence under UV or blue/violet excitation that is detectable with unaided eye. The colloids showed intense visible luminescence as shown in Fig. 6. However, the solutions of the as-milled Si nanocrystals did not show any detectable PL signal. Luminescence from colloidal Si nanocrystals has been previously observed, but such intense visible PL from crudely size separated core-shell Si nanostructures produced by mechanical milling is a significant

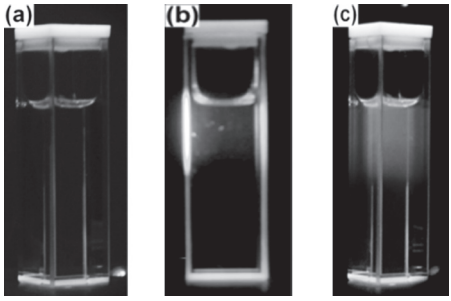


Fig. 6: Intense visible luminescence from colloidal suspensions of Si nanocrystals produced by oxidation of mechanically milled Si powder. (a) the colloidal suspension without any external excitation; (b) green/yellow luminescence under external excitation with 447 nm excitation of 10 mW Ar^+ laser; and (c) intense blue emission under excitation with 325 nm excitation derived from xenon source.

new finding of our group. PL bands with peaks at 500, 517, 527, 534 and 554 nm are obtained for the excitation wavelengths of 355, 457, 476, 488 and 514 nm respectively. The spectra for the different excitations are shown in Fig. 7.

We see from Fig. 7 that the Si nanocrystal/Si oxide core-shell samples exhibit enhanced blue-violet PL under UV excitation with energies ~ 3.5 eV. Such enhanced PL from Si/SiO_2 systems for UV excitation with wavelengths shorter than 400 nm has also been recently reported and attributed to UV radiation induced modification of nonradiative recombination centers that improves the emission yield.[13] Previously, Wilcoxon *et al*.[14] have reported PL peaks ranging from 1.8-3.6 eV for different cluster sizes and for different excitation energies, from colloidal Si nanocrystals. For excitation at 256 nm, their samples exhibited two PL peaks, an intense peak at 365 nm and a weaker peak at 600 nm. In that case the intense violet peak was assigned to direct electron-hole

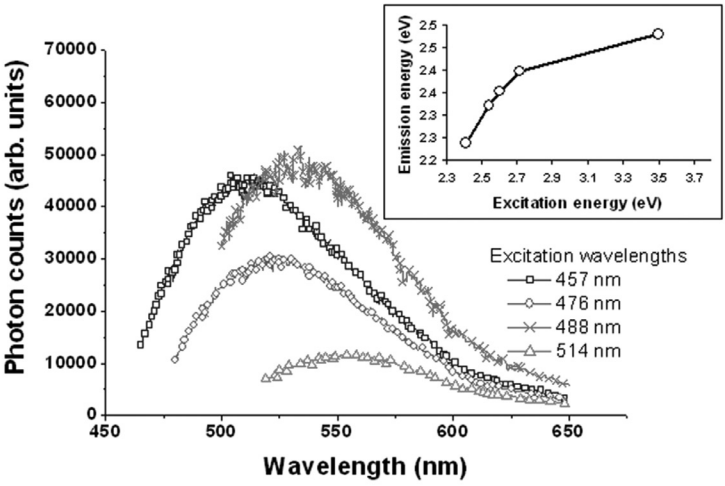


Fig. 7: PL spectra of the chemically and thermally oxidized Si nanocrystal dispersed in ethanol under external excitation with 2.71 (—▫—), 2.60 (—◦—), 2.54 (—×—) and 2.41 (—△—) eV monochromatic energies of an argon ion laser. The inset shows the variation of PL band peak energy with excitation energy. The emission-excitation data for excitation by 3.49 eV, which gave a peak at 2.47 eV, was obtained by exciting the sample with the 355 nm line of a Nd:YAG laser for recording the time resolved PL of the sample.

recombination, whereas the less intense PL peaks (~580 nm) were attributed to surface state and phonon assisted recombination.

Consistent blue shift of PL emission peak energies with increase in excitation energies was observed by Ding *et al*. from almost mono-dispersed (~2 nm) colloidal Si nanocrystal solution. Comparing their PL emission energies with that of electrogenerated chemiluminescence (ECL) data it was concluded that ECL is governed primarily by presence of surface states, while PL occurs mainly through excitation and emission within the nanocrystalline core.

In our case, we observe that PL band peaks appear in the green-yellow region for lower excitation energies and exhibit consistent red shift with decrease in excitation energy. We are inclined to suggest that oxide related defects at the interface of the Si nanocrystal and the surrounding oxide shell are the principal source of visible light.

The proposed mechanism hinges on three major observations: (i) stable and strong visible PL, detectable with unaided eye, is observed from chemically and thermally treated ball-milled Si but no measurable PL signal could be obtained from the as-milled samples; (ii) emission energy is blue shifted with increase in excitation energy; and (iii) absence of any detectable emission peak in the red or IR regime.

We attribute the observed PL to the dominant electronic transitions from the localized defect states to the band states via a three step process: (i) creation of electron-hole pair inside the crystalline core, followed by (ii) relaxation (non-radiative) of electrons to the defect states and (iii) subsequent de-excitation (radiative transition) of the electron to the valence band of the core. For the as-milled Si, the crystallites are far too large to affect any widening of the band gap and hence, despite the presence of interfacial and bulk defects, the transitions do not fall in the visible spectrum. Forced external oxidation reduces the crystallite sizes considerably (evident from Fig. 4). The reduction in size of the crystals opens up the band gap and when electrons are de-exited to the valence band of the Si-clusters, visible emission is observed. The phenomena cannot be explained solely on the basis of quantum confinement effect as that demands a large proportion of Si nanocrystals with sizes < 3 nm (for yellow-green emission). On the other hand, the exclusive contribution of defect related states also seems implausible. This is because the defect states are independent of particle size and thus expected to give detectable PL signal for the as-milled sample as well, which is contrary to our observation. The consistent red shift of the emission peak with decrease in excitation energy is discussed later.

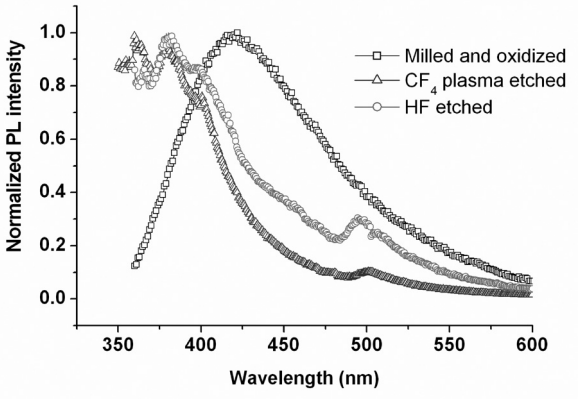


Fig. 8: Normalized PL spectra of the dry and wet etched samples along with the PL spectrum of Si nanocrystal/Si-oxide nanostructures produced by chemical and thermal treatment of mechanically milled Si. The spectra were collected by exciting the samples with 325 nm line of HeCd laser, 1 day after etching.

PL spectra of the etched samples along with an un-etched sample are shown in Fig. 8. The spectra in Figure 8 reveal the following features: (i) the dominant PL peaks of dry and wet etched samples centered around 359 nm and 380 nm respectively are blue shifted compared to the core/shell Si nanocrystal/Si-oxide nanostructures which has a PL peak at 419 nm for the same excitation; (ii) the CF_4 plasma etched samples exhibit a further blue shift by 21 nm (0.19 eV) compared to the HF etched nanocrystals; and (iii) RIE and HF etched samples are characterized by double peaks (in the emission range of 300-600 nm) with the a less intense peak at ~500 nm and this peak position is almost the same for both the etched samples for a given excitation. It may be noted here that the un-etched samples too exhibit double peaks, but the second peak is beyond 600 nm and hence not captured in Fig. 8. (iv) The high energy PL peaks are structured and similar to some significant previous reports.[14, 15]

Based on the optical and structural properties of the core/shell Si/Si-oxide nanostructures, we have proposed a three step transition mechanism responsible for PL from this system. However, while considering the different existing models of PL from Si nanocrystal/Si-oxide system, we were unable to completely rule out the possibility of emission from Si oxide and sub-oxide matrix. It is important to reflect on this possibility as blue emission from Si implanted in Si oxide layers has been attributed to non-stoichiometric composition of Si-oxide.[16] If stoichiometric SiO_2 is considered then the excitation energy required to obtain visible luminescence is much greater than 325 nm (which is the maximum excitation energy in this case), and such excitation energy is not enough to create non-equilibrium carriers across the band gap of SiO_2, which allows us to rule out the possibility of emission from SiO_2. But in the presence of non-stoichiometric suboxides of Si, the band gap is much smaller and may produce non-equilibrium carriers under UV excitation having lesser energy.[17] However, the possibility of emission from the suboxides seems remote. This is because, besides blue violet emission from the samples, an excitation dependent PL peak shift and appearance of double peaks are observed for all the nanostructures. In addition, here we see that the etched samples exhibit blue shift, where hydrogen passivation is more and non-stoichiometry is reduced. Such PL characteristics are difficult to explain in the framework of the suboxide model. On the contrary they provide direct evidence in favor of combined contribution of quantum confinement and interfacial defect states.

To illustrate the assertion made above, the proposed three step transition process is taken into account to understand the observed luminescent characteristics of the samples. The PL features of the RIE treated and the HF etched samples shown in Figure 8 is well explained by

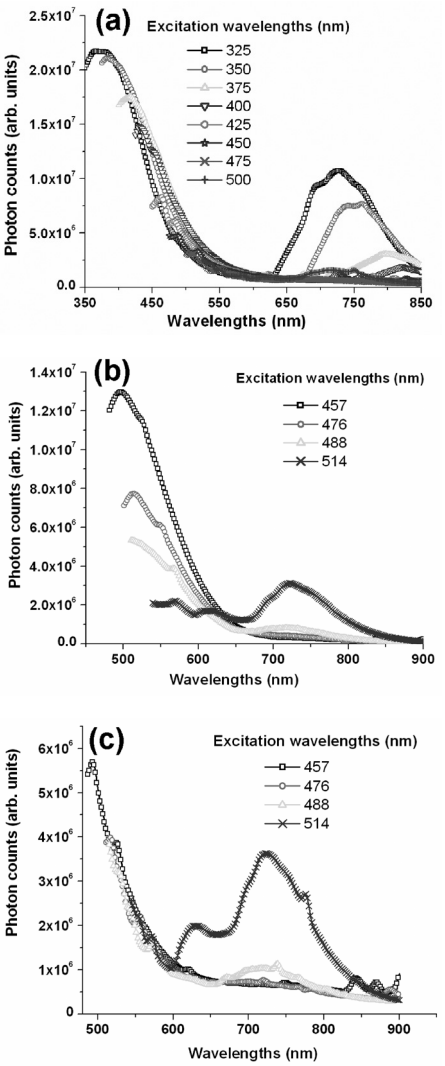


Fig. 9: PL spectra of colloidal suspensions (in isopropanol) of (a) 2 min CF_4/O_2 plasma etched sample under different excitations (as indicated in the figure) derived from xenon lamp and recorded with Flurolog-3 spectroflurometer; (b) and (c) 2 min CF_4/O_2 treated and 10% HF etched samples respectively. In this case the excitation source was a tunable Ar^+ laser. The spectra were recorded ~1 month after etching.

the proposed mechanism. TEM and XRD investigations of the etched samples confirm that both RIE and HF treatment introduces a further step of size reduction of the NCs. Therefore, it is expected that etching will cause an enhancement of band gap widening as a consequence of particle size reduction due to etching of Si. The model proposed by us suggests that the dominant peak in the blue-violet regime is due to band-to-band transitions and hence a reduction in average particle size should affect a blue shift of the PL peak. As expected the higher energy PL peak of plasma etched sample is further blue shifted compared to HF etched nanocrystals since size reduction of Si nanocrystals due to RIE is more than that of the samples etched with HF, which extends a direct support for quantum confinement model.

The appearance of multiple peaks in the region 350-400 nm in Fig. 8 is explained in terms of discretization of the phonon density of states in the isolated nanocrystals. In the colloidal suspensions of the nanocrystals the lattice waves cannot propagate from one particle to another *i.e.* the phonons become confined inside the particle. Removal of the relatively thick oxide shell removes the oxide related interface states present in the band gap and hence the treated samples exhibit more features compared to the un-etched ones, in confirmation with our proposed model.

To cross verify the luminescence results of the etched samples, PL spectra of the RIE and HF treated samples were also recorded by exciting the samples with 457, 476, 488 and 514 nm lines of Ar^+ laser as well as with different monochromatic wavelengths ranging from 325-500 nm, derived from xenon source and recorded by the Jobin Yvon Flurolog-3 spectroflurometer. Figures 9 (a)-(c) show the PL spectra obtained with the above excitations.

The features of the PL spectra of the etched sample are similar to that of the un-etched nanocrystals except for the fact that the PL peaks is further blue shifted for a given excitation. The dominant high energy peaks vary from ~360-514 nm for excitations ranging between 325-475 nm for the RIE treated samples. Here too the difference in the emission and excitation energy is very small implying that the thermal relaxation loss is very small. Therefore, the argument proposed to explain the luminescent characteristics of the core/shell nanostructures substantively explains the PL characteristics of the dry and wet etched samples as well. The presence of the lower energy peaks confirms the presence of oxide related interface states. On comparing figures 8 and 9 we see that the intensity of the lower energy peak in relation to the higher energy one increases with time, indicating the growth of oxide. Also, the features present in the high energy peak seem to disappear with time, *i.e.* with increased oxidation. This is expected if

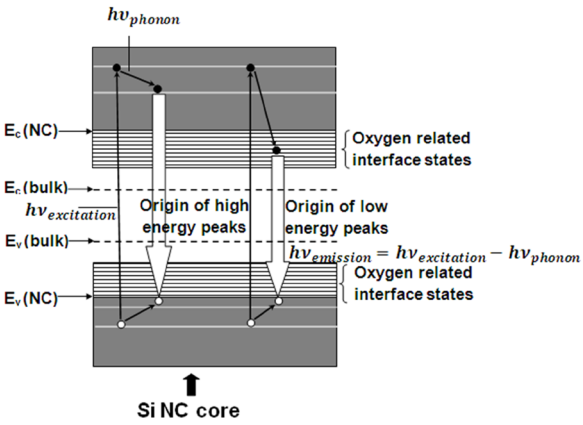


Fig. 10: Schematic representation of band structure and mechanisms responsible for PL from the samples.

we assume that the photogenerated carriers relax by emitting phonons corresponding to some discrete states, given that the lattice waves are confined within an isolated nanocrystal. With enhanced oxide coverage, available phonon states will increase since oxide layers offer potential barrier for electrons but not for phonons, and that accounts for the disappearance of features in the high energy PL peaks with time. In Figure 10, the portions indicated as oxide related interface states increase with oxidation whereas the energy gap between the conduction band edge and the valence band edge remains same for same size of the nanocrystals which explains the PL characteristics.

Another interesting feature noted here is that corresponding to the lowest energy Ar^+ laser excitation (514 nm), the lower energy peak is dominant. This phenomenon lends further support to the suggested transition process. Because of additional size reduction of the etched nanocrystals, lower excitation energy is unable to pump enough carriers across the widened band gaps of the ultra small particles, deep inside the conduction band. Consequently, the transition process is dominated by oxide interface assisted radiative recombination. Therefore, the luminescent characteristics support the fact that transitions between both quantum confinement induced widened band gap states (high energy peaks) and oxide related interface state mediated transitions (lower energy peaks) are responsible for visible emission from Si nanocrystals.

Plasmon Resonance in Metal Nanoparticles

Noble metal nanoparticles have been extensively studied primarily because of their unique optical properties associated with surface plasmon resonance (SPR).[18,19] Colloidal solutions of the noble metal nanoparticles like Ag and Au, exhibit very intense color which is otherwise absent in the bulk material as well as in the individual atoms. In fact, colloidal Au and Ag have been used as a coloring pigment dating back to the middle ages.[20] In the nineteenth century, Faraday,[21] recognized that the ruby red color of colloidal Au is due to the presence of aggregates of Au atoms. Around the turn of the twentieth century, colloidal chemistry was experiencing tremendous growth due to the pioneering contributions from Ostwald and Mie and the Nobel Prize winners Svedberg and Zsigmondy.[22] The work by Mie,[23] finally provided an excellent explanation of the origin of the red color in colloidal Au nanoparticles.

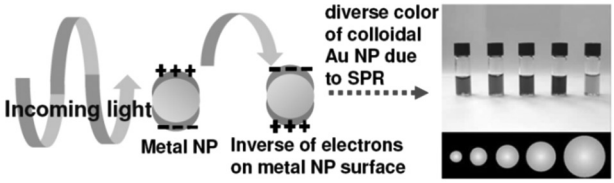


Fig. 11: (a) Origin of SPR due to coherent interaction of the electrons in the conduction band with light (after Ref [24]); (b) Formation of different color of Au nanoparticle colloids varying with size due to SPR.

Noble metal nanoparticles can localize and strongly enhance the incident electromagnetic field when excited at their plasmon resonance leading to the much observed SPR (Fig. 11). SPR in noble metals makes them excellent scatterers as well as absorbers of visible light, which opens the possibility of utilizing them in numerous applications. [25]

Origin of Plasmon Resonance

Their origin of color in colloids of metal nanoparticles is attributed to the collective oscillation of the free conduction electrons induced by an interacting electromagnetic field.[18] These oscillations are also denoted as surface plasmons. The total extinction cross-section, composed of absorption and scattering, is given as a summation over all electric and magnetic multipole oscillations. For nanoparticles small compared to the wavelength λ of the exciting light (λ < 2R, for gold 2R < 25 nm[19]) only the dipole absorption of the Mie equation contributes to the extinction cross section σ_{exi} of the nanoparticles. The Mie theory then reduces to the following relationship (quasi-static or dipole approximation)[26]:

$$\sigma_{exi} = \frac{9V\varepsilon_m^{3/2}}{c} \times \frac{\omega\varepsilon''(\omega)}{[\varepsilon'(\omega)+2\varepsilon_m]^2+\varepsilon''(\omega)} \quad \text{..... (1)}$$

The volume of the spherical particle is V, ω is the angular frequency of incident electromagnetic wave, ε_m and $\varepsilon(\omega) = \varepsilon'(\omega)+i\varepsilon''(\omega)$ are the dielectric functions of the surrounding medium and the metal respectively. Here ε' and ε'' denote the real and imaginary parts of the dielectric function of the particle material respectively. The position, shape and intensity of the plasmon band strongly depend on size, shape, the composition of the surrounding medium and interactions between stabilizing ligands and the nanoparticles. [27, 28]

Size Effect on the Plasmon Peak Position, Bandwidth and Intensity

From Equation (1), it can be inferred that resonance occurs when $\varepsilon'(\omega) \approx -2\varepsilon_m$, if $\varepsilon''(\omega)$ is small or weakly dependent on ω. The bandwidth and peak height are roughly determined by $\varepsilon''(\omega)$.[29] However, within the dipole approximation there is no size dependence and there is only an intensity variation with size as volume V depends on the particle radius R. Experimentally, one observes a strong size dependence of the plasmon bandwidth.[30] The position of the absorption maximum is also affected and both a blue-shift and a red-shift have been observed with decreasing particle size. Actually for small particles the dielectric function of the metal nanoparticles becomes size dependent [$\varepsilon = \varepsilon(\omega, R)$] and render a size-dependent absorption cross-section even within the dipole approximation (intrinsic size effects).[30] The size dependence of the dielectric constant is introduced as the diameter of the particle becomes smaller than the mean free path (MFP) of the conduction electrons. This classical picture of the limitation of the MFP due to surface scattering has been suggested by Kreibig which results in a $1/R$ dependence of the plasmon bandwidth and has good agreement with experimental results.[31] In a quantum mechanical model, Kawabata and Kubo[32] argue that the surface does not act as a scatterer but mainly determines the energy eigenstates of the system and the decay or damping of the plasmon absorption is caused by transfer of its energy to the excitation of individual electronic states.

For larger nanoparticles ($2R > 25$ nm) the extinction cross-section is also dependent on higher-order multipole modes within the full Mie equation and the extinction spectrum is then also dominated by quadrupole and octopole absorption as well as scattering.[33] These higher oscillation modes explicitly depend on the particle size and with increasing size the plasmon absorption maximum is shifted to longer wavelength

and the bandwidth increases. The total plasmon band absorption will be then the superposition of all contributing multipole oscillations peaking at different energies. The excitation of the higher-order modes is explained in terms of an inhomogeneous polarization of the nanoparticles by the electromagnetic field as the particle size becomes comparable to the wavelength of the exciting radiation. The broadening of the plasmon band is then usually ascribed to retardation effects. On the other hand, the increased line width or equivalently the faster loss of coherence of the plasmon resonance could qualitatively also be described as a result of the interactions between the dipole and the quadrupole (and higher-order) oscillatory motions of the electrons, thus destroying the phase coherence.

It is well reported that if the particle size increases the plasmon band frequency (*i.e.* absorption maximum) shifts to longer wavelength and plasmon bandwidth also increases with size. One such case is shown in the Fig. 12.

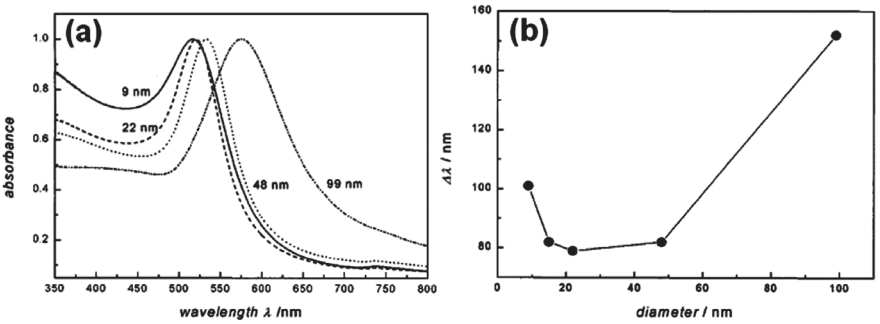


Fig. 12: (a) UV-vis absorption spectra of 9, 22, 48, and 99 nm Au nanoparticles in water. All spectra are normalized at their absorption maxima, which are 517, 521, 533, and 575 nm, respectively; (b) Plasmon bandwidth $\Delta\lambda$ as a function of particle diameter (after Ref. [34]).

The absorption peak intensity is primarily dependent on the absorption cross-section of individual particle. It has been theoretically as well as experimentally

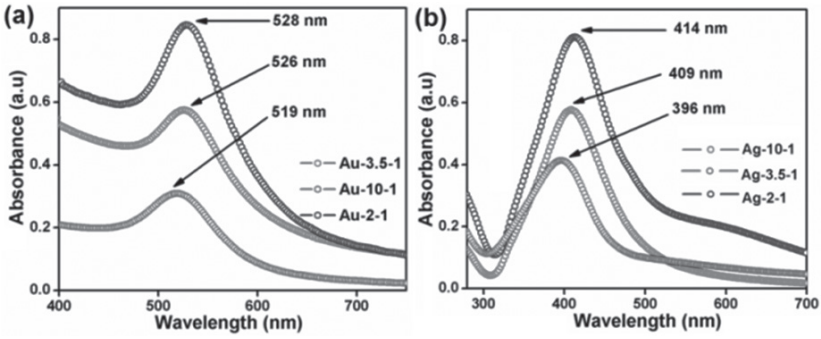


Figure 13: UV-vis absorption spectra of: (a) Bare Au nanoparticle with particle size ~7, 24 and 34 nm for Au-3.5-1, Au-10-1 and Au-2-1 respectively; (b) Bare Ag nanoparticle with particle size ~7, 22 and 28 nm for Ag-10-1, Ag-3.5-1 and Ag-2-1 respectively. In both cases the plasmon peak is blue-shifted with increasing particle size.

observed that the absorption cross-section increases with the particle size for Au and Ag nanoparticles.[35] Hence larger particle size will have the larger intensity of absorption spectra which is shown in Fig. 13.

We have also observed this phenomenon in our lab and case is shown in Fig.13. For bare Au nanoparticles when the molar concentration ratio of Na_3-Ct: $HAuCl_4$ was 3.5:1 then the average size was ~7 nm. The size increased for 10:1 and 2:1 ratio to ~24 and 34 nm respectively. Correspondingly the absorption maxima shift from 519 nm to 526 and then to 528 nm respectively [Fig. 13 (a)]. The absorption peak of Ag nanoparticles too exhibit the same feature as illustrated in Fig. 13 (b) wherein we see that the plasmon peak red-shifts from 398 to 414 nm for Ag nanoparticle sizes varying from ~7 to 30 nm respectively.

From the spectra (Fig. 13) we calculated the FWHM. For the smallest Au nanoparticles, the FWHM is estimated to be ~58.4 nm whereas for larger ones (~16 and 22 nm) they were ~46.4 and ~47.8 nm, respectively. Same way for the smallest Ag nanoparticles the FWHM is ~83.3 nm, whereas, in case of ~15 and 28 nm particle they are increased to ~80.2 and 74.7 nm, respectively. These results suggest a 1/*R* dependence of the plasmon bandwidth.

Medium Effect on the Plasmon Peak Position and Bandwidth

The refractive index of the medium surrounding the metal particles can influence the frequency of their plasmon bands.[36, 37] A higher refractive index of the medium produces a lower plasmon frequency. Assuming that an oscillating weighted spring represents the electric field of the surface plasmon and a high dielectric medium to represent a viscous medium like oil, and then a spring in a vacuum will oscillate with a higher frequency than the spring in the oil. That is the reason that when the metallic nanoparticles are surrounded with higher refractive index material the absorption peak will appear in higher wavelength.

'1/R' dependence of the plasmon bandwidth is furthermore predicted by a more recent quantum mechanical theory by Persson[38] considering the chemical nature of the nanoparticle surrounding interface. Following this model, an additional broadening of the plasmon band is caused by the transfer of the excitation energy into adsorbate levels located above the Fermi level. This model is therefore, called chemical interface damping and excellent quantitative agreement was found by Kreibig and co-workers[39] by measuring the same 2 nm Ag nanoparticles in a vacuum (naked clusters) and embedded into a SiO_2 matrix. Chemical interface effects could thus be isolated from size effects. In this context it is important to consider that the thickness of the citrate, surrounding the metallic nanoparticle, is so small that it will not be a cause of plasmon peak shift. In addition, shape of the nanoparticles and aggregation can also alter the plasmon peak. Here we refrain from detailed discussion on the effect of these two factors.

Conclusions

With reference to light emission from Si nanostructures and plasmon resonance in Au nanoparticles we see that size plays a significant role in determining the so called "size-independent" material properties when the dimensions of the material particles are reduced to the nanoscale. The two case studies also elaborate that in addition to size; shape, defects and surface configuration of the nanomaterials also have important roles to play in determining their properties. Of course, for a given nanomaterial the

properties are also a function of the immediate neighborhood as we have explicitly seen for Au nanoparticles, where the plasmon resonance peak shifts depending on the surrounding medium. The study of nanomaterial has so far revealed many interesting features and has opened up lots of potential applications. However, a lot remains to be achieved both in terms of basic theoretical understanding as well as for real life applications – which makes this particular branch of science and engineering an extremely promising field.

1. Nano on reflection, Nature Nanotechnology, **11**, 828–834, 2016
2. M. Reibold, P. Paufler, A. A. Levin, W. Kochmann, N. Pätzke and D. C. Meyer, Nature, **444**, 286, 2006
3. C. Zhou, M. Long, Y. Qin, X. Sun and J. Zheng, Angew. Chem. **50**, 3168–3172, 2011
4. C. N. R. Rao, P. J. Thomas and G. U. Kulkarni, Nanocrystals: Synthesis, Properties and Applications, Springer-Verlag, Berlin Heidelberg, 2007
5. S. Ossicini, L. Pavesi, F. Priolo, Light emitting Si for microphotonics, Springer-Verlag, Heidelberg, 2003
6. N. Daldosso and L. Pavesi, Si nanocrystals enabling Si photonics, in: L. Khriachtchev (Ed) Si nanophotonic: basic principle, present status and perspectives, World Scientific, Singapore, 2009
7. S. Godefroo, M. Hayne, M. Jivanescu, A. Stesmans, M. Zacharias, O.I. Lebedev, G. Van tendeloo, V.V. Moshchalkov, Nature Nanotechnology **3**, 174-78, 2008
8. T. E. F. M. Standaert, C. Hedlund, E. A. Joseph, G. S. Oehrlein and T. J. Dalton, J. Vac. Sci. Technol. A, **22**, 53-60, 2004
9. T. D. Shen, I. Shmagin, C. C. Koch, R. M. Kolbas, Y. Fahmy, L. Bergman, R. J. Nemanich, M. T. McClure, Z. Sitar, and M. X. Quan, Phys. Rev. B **55**, 7615-7625, 1997
10. S. N. Magonov, V. Elings, and M. H. Whangbo, Surf. Sci. **375**, L385-L391, 1997
11. W. W. Scott, and B. Bhushan, Ultramicroscopy, **97**, 151-169, 2003
12. C. H. Lei, K. Ouzineb, O. Dupont, and J. L. Keddie, J. Coll. Interf. Sci. **307**, 56–63, 2007
13. P. T. Huy and P. H. Duong, Advanced Materials Research, **31**, 74, 2008.
14. J. P. Wilcoxon, G. A. Samara P. N. and Provencio, Phys. Rev. B, **60** 2704-14, 1999
15. Z. Ding, B. M. Quinn, S. K. Haram, L. E.Pel, B. A. Korgel and A. J. Bard, Science, **296**, 1293-7, 2002
16. L. Rebohle, J. von Borany, H. Fröb and W. Skorupa, Appl. Phys. B, **71**, 131-51, 2000
17. W. Skorupa, R. A. Yankov, L. Rebohle, H. Fröb , T. Böhme, K. Leo, I. E. Tyschenko G. A. and Kachurin Nucl. Instrum. Methods Phys. Res., Sect. B, **120**, 106-9, 1996
18. A. Henglein, Chem. Rev. **89**, 1861, 1989
19. G. Schmid, Clusters colloids: From theory to application, VCH: Weinheim, 1994
20. M. Kerker, J. Colloid Interface Sci. **105**, 297-314, 1985.
21. M. Faraday, Philos. Trans. R. Soc. London **147**, 145-181, 1857
22. V. Sharma, K. Parka, and M. Srinivasarao, Mat. Sci. Eng. R **65**, 1–38, 2009
23. G. Mie, Ann. Phys. **25**, 376-445, 1908
24. S. Eustis, and M. A. El-Sayed, Chem. Soc. Rev., **35**, 209–217, 2006

25. M. A. Garcia J. Phys. D: Appl. Phys. **44** 283001, 2011
26. C. F. Bohren, and D. R. Huffman, Absorption and scattering of light by small particles, Wiley: New York, 1983
27. S. Link, and M. A. El-Sayed, J. Phys. Chem. B **103**, 4212-4217, 1999
28. S. Link, and M. A. El-Sayed, Int. Rev. in Phys. Chem. **19**, 409-453, 2000
29. U. Kreibig, and M. Vollmer, Optical properties of metal clusters, Springer series in materials science, Berlin, 1995
30. U. Kreibig, and L. Genzel, Surf. Sci. **156**, 678-700, 1985
31. U. Kreibig, and C. v. Fragstein, Z. Phys. **224**, 307-323, 1969
32. A. Kawabata, and R. Kubo, J. Phys. Soc. Jpn. **21**, 1765-1772, 1966
33. G. C. Papavassiliou, Prog. Solid State Chem. **12**, 185-271, 1980
34. S. Link, and M. A. El-Sayed, J. Phys. Chem. B **103**, 4212-4217, 1999
35. P. K. Jain, K. S. Lee, I. H. El-Sayed, and M. A. El-Sayed, J. Phys. Chem. B **110**, 7238-7248, 2006.
36. M. Pelton, J. Aizpurua, and G. Bryant, Laser Photonics Rev. **2**, 136–159, 2008
37. A. C. Templeton , J. J. Pietron , R. W. Murray, and P. Mulvaney, J. Phys. Chem. B **104**, 564–570, 2000
38. B. N. J. Persson, Surf. Sci. **281**, 153-162, 1993
39. H. Hövel, S. Fritz, A. Hilger, and U. Kreibig Phys. Rev. B **48**, 18178–18188, 1993

150th Birth Anniversary Celebration

ANALYSIS OF SPORTS COVERAGE OF PRINT MEDIA FOR RIO OLYMPIC BEFORE AND AFTER 15TH AUGUST 2016 IN RESPECT OF WOMEN ATHLETES' PERFORMANCE

Mitrali Chakraborty [a], Dr. Pintu Sil [b*]

[a]Scholar, MPEd, Sem-III+, [b]Assistant Professor,
State Institute of Physical Education for Women
Hastings House, Alipore, Kolkata, India

Abstract

Purpose: Several studies reported about existence of gender disparity in the sports content of print media around the world. The purpose of the research was to find out the impact of women sports performance in Rio Olympic before and after 15th August 2016 in respect of gender disparity in sports coverage. ***Methodology:*** For this purpose, the content of the sports coverage related with Rio Olympic in Newspapers on and from 3rd August to 23rd August 2016 were analyzed. The coverage was classified into two categories, before 15th August (P1 Period) and 15th August onwards (P2 period) and difference were compared between each other from the angle of gender inequality in sports news publication. Four leading daily newspapers on Bengali and English published in Kolkata, West Bengal were considered for this study. Variables considered in this study were area covered for total news (ACTN) and area covered for photograph (ACPH). Measurement was done by calculating the area in Sq. Cm. of the newspaper using simple geometric scale. Mean and standard deviation was used as descriptive statistics and t-test was used for comparison between the male and female athletes' sports coverage. All statistical calculations were done using standard statistical software (Excel, 2010) and 0.01 level of significance was considered for the present study. ***Results:*** Results revealed that mean values of ATCN and ACPH for male athletes were higher than the female athletes for P1 period but mean values of ATCN and ACPH for female athletes were higher than the male athletes for P2 period. All calculated t-values for P1 period for ATCN ($t = 2.75$) and ACPH ($t = 3.57$) and for P2 period for ATCN ($t = 2.39$) and ACPH ($t = 3.17$) has found statistically significant. ***Conclusion:*** From above results it was concluded that male athletes received significantly higher coverage in news writing and pictorial section than the female athletes of Rio Olympic in P1 period. With the mind-blowing performance of the female athletes the scenario was entirely changed and t-values for P2 period was significantly higher for female athletes than the male athletes. These findings might be indication of women empowerment in Indian sports scenario.

Keywords: Sports coverage; Print media; Leading Newspapers; Gender disparity; Women empowerment.

* Corresponding author: E-mail: silpintu@gmail.com

ISBN : 978-81-933395-0-3

Introduction

We often say that women should get equal opportunity in every aspect of life. But in reality what is the scenario? Not only in our country, throughout the world there are so many areas that are socially and even sometimes legally banned for females. Wrestling was considered as male's sport in India before Saakshi Malik got the Olympic bronze medal. But to reach that podium she had to wrestle against the entire society surrounded her.

Gender disparity exists in every sphere of the society. With the sports arena gender inequality has also existed in the media coverage for sports. Several studies in recent years have reported about the existence of gender inequality in sports news publication and pictorial coverage. Media portrayals of male and female athletes in the 1984 and the 1988 summer Olympic Games as reflected in *The Globe and Mail* in Canada and *The New York Times* in USA was analyzed and found that men received more attention and more favorable portrayals than women in sports news in the mass media[2]. *The Globe and Mail* for one year was analyzed and found males received significantly more coverage than the females in print, pictorial and editorial space[3]. Sil (2013) reported significant lower news and pictorial coverage for Shelly Ann Fraser-Pryce than Usain Bolt for same achievements in 14th World Athletic Championship.[4] Das and Sil (2014) found that Women cricketers received significantly lower sports coverage than male cricketers for ICC World Twenty-20 Cricket Championship in 2014.[5] Talukdar and Sil (2015) also reported significant lower sports coverage for women athletes than male for XX Commonwealth Games and XVII Asian Games 2014 sports meet.[6]

The present study was designed to find out the existence of gender inequality in Print media of Bengal. Investigation was done using the sports coverage of print media for both female and male athletes of India participated in Rio Olympic. Study tried to find out whether both gender of athletes had received same importance in coverage of print media or not and what was the impact of women's performance in Rio Olympic on sports coverage.

Materials and Methods

A total of four daily leading newspapers, published in West Bengal, India on and from 3rd August to 23rd August, 2016 were considered for the present study (list of the papers has attached in appendix). The content of the sports coverage related with Rio Olympic in Newspapers on and from 3rd August to 23rd August 2016 were analyzed. The coverage was classified into two categories, before 15th August (P1 Period) and 15th August onwards (P2 period) and difference were compared between each other from the angle of gender inequality in sports news publication.

Variables measured for this study were area covered for total news (ACTN) and area covered for photograph (ACPH). Both the variables were calculated on the coverage before and after 15th August (*i.e.* P1 and P2 Period).

Simple geometric scale was used as tool of measurement.

Mean and standard deviation were calculated as descriptive statistics and difference between two means was measured by t-test. Significance level was set at 0.01 level in this study.

Results and Findings

Mean and SD of ACTN (area covered for total news), ACPH (area covered for photograph) for both genders for P1 period and P2 period and the result of t-test for both variables between two genders have presented in Table-1.

Table 1 : Mean and SD of considered variables and t-values between both genders before and after 15th August

Variables		Male		Female		t-value
		Mn	***SD***	***Mn***	***SD***	
ACPH	P1 Period	529.63	311.93	366.76	204.285	3.57*
	P2 Period	576.39	489.75	992.936	838.877	2.39*
ACTN	P1 Period	1056.46	509.13	800.273	506.193	2.75*
	P2 Period	1279.97	737.09	2080.01	1524.326	3.17*

* *Significant at 0.01 level*

Table-1 has shown that mean values of ATCN and ACPH for male athletes were higher than the female athletes in P1 period. But female athletes have higher mean values than the male athletes in P2 period. In order to judge the difference between two means t-test was computed and calculated t-values for P1 period ATCN (t = 2.75) and ACPH (t = 3.57) and for P2 period ATCN (t = 3.17) and ACPH (t = 2.39) has found statistically significant. The mean coverage of ACTN and ACPH in print media as measured in this study for both gender was converted in percentage value and presented

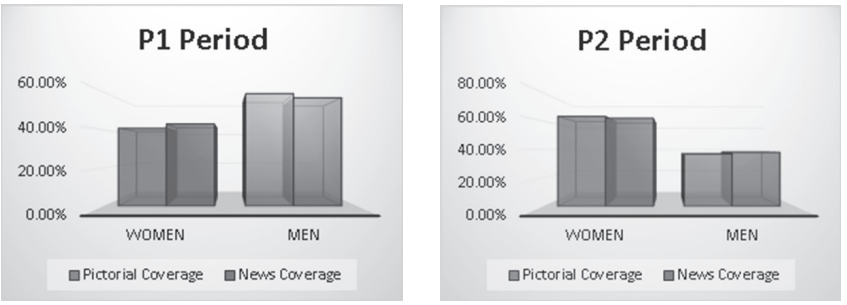


Fig.1: Pictorial and News coverage of print media for both variables in respect of gender before and after 15th August

in Figure-1. The figure has shown the superior percent of coverage in both pictorial and news area for male sportspersons than female in P1 period and for female sportspersons than male in P2 period.

Discussion on Findings

This discrimination in sports coverage for male athletes is not a regular thing. Previous studies in this aspect have shown that there was a significant gender disparity in sports

news coverage[7, 8, 9] where females were always dominated by males. In the beginning during P1 period the result was the same in favor of male athletes but in later stage at P2 period the scenario has entirely changed. Not because of a massive change in thinking pattern of entire society and media, but because of the results of India women athletes' performance in Rio Olympic. India has got only two medals from Rio Olympic and both the medal winners were females. Beside these result the 1st women athlete of India who participated in Gymnastics and has shown super performance in vaulting event in final missing the bronze medal by 0.15 score. So the women athletes only save the India's grace and pride in Olympic by winning medals and nation's heart. That was the reasons for which there was no way other than giving more sports coverage in news and pictorial form to the female athletes. The study also shows that there is significant difference in sports coverage between male and female athletes before and after 15th August. Before 15th August pictorial and news both area of coverage was higher for male athletes than female athletes. But after Dipa Karmakar's super performance the scenario changed. Then Saakshi and Sindhu flooded the whole nation as well as the sports coverage. This might be a good indication to the society that time is changing. Women are no more in back foot in sports in India as well as in the world. They already have proven their capability in different sphere of sports. These findings might be considered as women empowerment in the field of sports scenario of India which was noticed earlier in the another study conducted by Sil (2015). [10]

Conclusion

On the basis of above discussion following conclusion have been drawn for the present study:

1. Print media covered significantly greater sports news and pictorial coverage for the male athlete than the female athlete regarding the Rio Olympic Games before 15th August.
2. Print media published significantly more sports news and pictorial coverage for the female athletes than the male athletes regarding Rio Olympic Games after 15th August.

References

1. J. Knijnik, Visions of Gender Justice: Untested Feasibility on the Football Fields of Brazil. *Journal of Sport and Social Issues*, 37(1), 8-30, 2013
2. J. Lee, Media Portrayals of Male and Female Olympic Athletes: Analysis of Newspaper Accounts of the 1984 and the 1988 Summer Games. *International Review for the Sociology of Sport,* 27(3). 197-219, 1992
3. J. Crossman, P. Hyslop and B. Guthrie, A Content Analysis of the Sports Section of Canada's National Newspaper with Respect to Gender and Professional/Armature Status. *International Review for the Sociology of Sport*, 29(2), 123-132, 1994
4. P. Sil, Gender Disparity in the Content of Sport Coverage in Print Media, *Proceedings of National Seminar on Physical Education: Interdisciplinary Approach (NSPEIA_2014); NERC-LNIPE*, Guwahati, Assam; P-143-146.

5. Das, J. and Sil, P. (2015), Biased Voice of Print Media: Gender Disparity in Sports Coverage for ICC World Twenty-20 Cricket 2014; HORIZON PALAESTRA-*International Journal of Health, Sports and Physical Education;* Vol.3, No.2, P: 17-19, 2014
6. P. Talukdar, P. and P. Sil, An analysis of the content of sports coverage of print media for Commonwealth and Asian games with respect to gender; Selected paper for *International Conference on Physical Education and Sports* organized by JERCE University, Jaipur, Rajasthan on February 2015.
7. M.C. Duncan, Gender warriors in sports: Women and the media. In A.A. Raney & J. Bryant (Eds.), *Handbook of Sports and Media, Mahwah*, NJ: Lawrence Erlbaum Associates, 231-252, 2006.
8. S.T. Eastman & A.C. Billings, Biased voices of sports: Racial and gender stereotyping in college basketball announcing. Howard *Journal of Communications*, 12(4), 183-202, 2000.
9. P. Sil, Women empowerment: An Analysis of the sports Content of Print Media with Respect to Gender. *Modern Trends in Social and Basic Sciences*; Tandrica Dhaduri for readers service SP Communications Pvt. Ltd, 865-869, 2015.

Appendix

List of the Newspapers considered for the present study:

- Bengali Newspapers: Anandabazar Patrika, Aajkal
- English Newspapers: The Telegraph, Times of India

SISTER NIVEDITA AND WOMEN'S EMPOWERMENT

Maumita De [a*]

[a] *Department of Philosophy, Sister Nibedita Govt. General Degree College for Girls, 20 B Judges Court Road, Hastings House, Kolkata-700027*

Introduction

This year we are celebrating the birth anniversary of such a woman who have sacrificed her whole life for the sake of mankind; she is Margaret Elizabeth Noble formerly known as Sister Nivedita. Swami Vivekananda her spiritual guide gifted her for the enlightenment of India and gave her this name when he initiated her into the vow of Brahmacharya on 25th March, 1898. To make that name significant she devoted hole of her life in the service of humanity especially, for the empowerment of women. She left her own country and countrymen in the call of India and gave her all for the betterment of this country. Swamiji in his teaching made her aware about the glorious past of India and pointed out that India will never be awakened unless the Indian citizens regain their self confidence. Indian people needed to be perceived again the great Upanishadik vow "SO AHAM"; I myself is the almighty, Omnipotent BRAHMAN.

Women's Education

Nivedita was well aware about the fact that no social reformation of India will be possible without the empowerment of women. Now, the question raises, What is meant by "Women's Empowerment"? "Women's Empowerment" refers to increasing and improving the social, economic, political and legal strength of the women, to ensure equal right to women and to make them confident enough to claim their rights such as independent living, to make their own choices and decisions, have equal status in the society and equal rights to participate in religious, social and economic activities. For empowering the Indian women Nivedita felt they should be educated first. She also realized that this education never will be the blind follower of western culture but it will be their own; they have to be acquainted with their glorious past. Swami Vivekananda assigned her duty to educate Indian women. Swamiji also advised her, our duty is to educate them only, education means proper education but not to decide their way of life; they will decide that at their own if they got a proper education.

Swamiji firmly believed that, the pride of present India will exceed even the glory of Ancient India. He also believed that the pride of present Indian women will exceed

* Corresponding author: Email: maumitade@gmail.com, Phone: 8583970220

ISBN : 978-81-933395-0-3

the pride of Vedic, Upanishadik women. A proper method of education for women will teach them modern scientific knowledge and also help them to develop all the qualities of ancient Indian women. The future women according to Swamiji will be a combination of ancient heroic quality and motherly gentleness.[1]

Sister believed in the definition of education given by Swamiji : "Education is the manifestation of perfection already in men."[2] Thus, she only tried to unveil that perfection which is already prevailed in men and women. To do so she has taken the help of ancient Indian scriptures. In her different speeches Nivedita mentioned that education is not some medicine in a bottle which can apply in a regular dose. The principal element of the education for Hindu women is in their ancient scriptures. She continued, to determine the method of education for a Nation we have to know thoroughly their lifestyle and conditions with adequate honour and patience. The ideal of Indian women is not love but sacrifice. Since with the practice of sacrifice she had like to introduce them with the practical knowledge of West. [3]

Building up a Nation

In Modern Review (a well-known 20th century London based magazine) F. R. Alexander wrote about Sister Nivedita's role in the Indian Renaissance that in building up the structure of the Indian awakening Nivedita played a role of an architect; in her mind has drawn in firm lines the whole master plan and the method of execution of the plan for the reconstruction of the nation. And she was well aware that Indian awakening is not possible until the half of the society–the class of women is not awakened. To determine the aim of women's education she wrote: "There can never be any sound education of the Indian women which does not begin and end in exaltation of the national ideals of womanhood as embodied in her own history and heroic literature."[4] Here she mentioned the examples of Sita and Savitri how they were devoted on their duties and satisfied every demand of social ideal.

According to Nivedita a learner must be remembered that the aim of development is not only the betterment of self but it's main aim is to be the betterment of public, country and religion. The education which aims at that can make a proper human being. When the love for the country firmly stamped in the heart and educate one to honour their own culture and ideal then the person can feel the greatness and understand the higher ideals of the others nation; unless the blind following of others nation in the name of Internationism makes inferior the character.

Establishment of School

Sister never done an armchair thinking for the renovation of society and upliftment of women but her work was very much practical. To the end of empowering Indian women she founded a school exclusively for girls on 13th November, 1898 (in a day of Kali Puja) in the Baghbazar area. At the then India most of the women were deprived even from the basic education. The left chart shows the rate of literacy in India during the period of 1901—1921.

Year	*Male*	*Female*
1901	9.8	0.7
1911	10.6	1.1
1921	12.2	1.8

She visited door to door by asking people to send their daughter to her school. Beside general education she taught sewing, nursing, maintaining hygiene, etc. During the plague outbreak in Kolkata on 1899 she trained womenfolk about the preventive measures and distributed written instructions among them.

For this school Swamiji advised her, 'complete rule with complete freedom'— will be the uniqueness of our institution. There must be some rules in this institution but they will never be too rigid.[5] But to establish a properly beneficial educational institution Nivedita needed sufficient money and manpower. In the then India, it was unexpected that a Hindu maiden girl will give all her life for the sake of women's education. Thus, she has chosen young orphan widows to train them for that noble cause. Now for them she needed an accommodation, an ashram where she can taught them.

Foreign Travel for Collection of Money

For the smooth running of her school and to establish an ashram for widows and orphans Nivedita needed money and Swamiji suggested her for traveling America to collect money but her mind denied. She was afraid about her new born school. But it was not too easy to carry on the work of her school. First, the scorching summer came, moreover, one by one of her students got married. Now, she strongly felt the need of an ashram where she can make a group of future teachers who can carry out her dreamt project. Now, she agreed to go for America.

In June, 1900 she closed her school temporarily and started for America and Europe. She came to the New York and met with Swami Abhedananda. Abhedananda already mentioned about Nivedita's school in his lecture 'Women in Hindu Society' delivered in New York, now he joined with her to collect money for the school. Nivedita was an excellent orator. She delivered many lectures in Chicago, Detroit, New York and other cities of America. She delivered her lectures on 'The Condition of Indian Women', on 'The Religious Life of India', on 'Ancient Indian Art', etc. In this way she has collected some money for her dreamt project. She also visited England and delivered her lectures for the same purpose. In England she met with the Indian historian Mr. Ramesh Chandra Dutta. Mr. Dutta encouraged her to write a book on Indian life and assured her that she should be accumulated the money for her school from this writing.

Sister's life in the America and England was not too easy. She was insulted again and again, faced the challenges of missionaries, even the club members of a club of Edinburgh tried to snatch her right to deliver speech in different clubs. But Nivedita faced all the challenges with her strict personality and tried to give them their appropriate answer. She published her essay "Lamb among Wolves" in the West Minister Gazette as an answer of missionaries attack.

Gradually she became famous among the ladies of different clubs. Through her hard work and sincerity she became successful to make a circle of her well wishers. She got the financial help from them for her school and ashram. With the help of them she established 'The Ramakrishna Help Association' and published a plan of action for Ramakrishna Girls' School. Mrs. H. Leggett became the principal of that association and Mrs. Sara Bull became the secretary.[6]

In this plan of action she expressed her wish to establish a school for Indian girls and women near the river Ganga. The said school will be directed under Maa Sarada, Sri Ramakrishna's wife. Again she expressed her wish to establish an art school in

the same premises. Kindergarten method will be the method of teaching there and the subject will be English and Bengali language and literature, primary mathematics, primary science, and handicrafts as each and every student can earn their livelihood in their own. She also maintioned that, if the school runs properly, a group of students should be produced in fore future who will be offered themselves for the country. They will be the next generation of this work and under their guidance many Ramakrishna Girls' Schools will be established everywhere in India. [7]

Departure from Ramakrishna Mission and Own Way of Work

Just after returning from foreign travel Nivedita faced a great disaster— Swamiji expired. Swamiji left this world on 4th July 1902 and Sister departed from the Ramakrishna Mission on 17th July, as Swami Brahmananda the then President of Ramakrishna Mission suggested her to change her policy of work as that was violated the rules and regulations of Mission. It was clearly mentioned in the rule of Ramakrishna Mission that it is a quite religious organisation and it has no connection with politics. But in that time Nivedita was directly connected with the different political leaders and she thought that it is her duty to support the freedom fighters for the sake of her beloved India. Thus, a conflict rose between Nivedita and Ramakrishna Mission. Though she left the Ramakrishna Mission but never left Swamiji and Ramakrishna. Before this she wrote 'Nivedita of the Ramakrishna order' and then she started to write 'Nivedita of Ramakrishna and Vivekananda'. On the other hand her brethren also never left their sister. Swami Brahmananda, Swami Saradananda was always with her.

Swamiji's death was a great jerk for Nivedita but being a Karma Yogin she never left her work. She engaged herself in the work of her school and her writing. She wrote for India, wrote for Indian nation and culture and also for Indian women. But she gave up the dream for making ashram after departing from the Mission and fully concentrated on her school.

Sister Nivedita was a prolific writer. At that time when most of the Indian people started to follow Western culture blindly, this foreign lady tried her best to make them aware about the greatness of Indian culture, Upanishadik teachings. She appealed to the Indian youth to work selflessly for the cause of the motherland and humanity along with the ideals of Swamiji. She also inspired youth by editing the newspaper Karma Yogin founded by Sri Aurobindo. In her book *Myths of the Hindus and Buddhists* she wrote, "..... a single generation enamoured of foreign ways is almost enough in history to risk the whole continuity of civilization and learning." [8]

In her book *The Web of Indian Life* Sister Nivedita seeks to rectify many dogmatic myths about Indian culture and customs those were frequent in western world. In the same book she wrote, "For thousands of years must Indian women have risen with the light to perform the Salutation of the threshold. Thousands of years of simplicity and patience like that of the peasant, like that of the grass, speak in the beautiful rite. It is this patience of woman that makes civilizations. It is this patience of the Indian woman, with this her mingling of large power of reverie, that has made and makes the Indian nationality." [9]

In her essay "The Present Position of Women" Sister denied the Western classification of women and proudly remembered the glorious past of India. She wrote, "In India also women have held power, from time to time as rulers and administrators,

often with memorable success." In *The Cradle Tales of Hinduism* Sister Nivedita retold the stories from Puranas and from the two Epics—Ramayana and Mahabharata. Here she highlighted the roles of women characters like Kunti, Draupadi, Sita, Savitri etc. In her books *Religion and Dharma* and *Myths of Hindus and Buddhists* she refuted the dogma that only the man have their right to salvation and advocated the Upanishadik view and Swamiji's teaching that everything is the manifestation of the supreme truth: BRAHMAN, differences only exist in the level of appearance.

Beside girls' school she started a different school for housewives and elderly ladies on 2nd November,1903. Smt. Labanyaprabha Basu, Sister Christine and Yogin Maa were appointed as their teacher. She also organised different programmes and lectures for them. For example, on 26th October, 1903 a programme was organised about Gita and Swami Saradananda was the speaker there. Gradually the number of students increased. With 17, Bose Para Lane Sister also hired the 16 Bose Para Lane for her school.

Conclusion

Sister Nivedita had done a lot for Indian women as well as for Indian people. A.J.F. Blair marked her as the "white flower of nobility". Her epitaph reads "Here reposes Sister Nivedita who gave her all to India".

Notes:

1. Prabrajika Muktiprana, *Bhagini Nivedita*, 9th ed., Sister Nivedita Girls' School, p. 145-146, 2012.
2. Letter to Singaravelu Mudaliyar, Chicago, U.S., 03/03/1894.
3. Prabrajika Muktiprana, *Bhagini Nivedita*, 9th ed., Sister Nivedita Girls' School, p. 194, 2012.
4. Sister Nivedita, *Hints on National Education*, 4th ed., Udbodhan Office, Kolkata, p. 59, 1950.
5. *Bhagini Nivedita*, 9th ed., Prabrajika Muktiprana, Sister Nivedita Girls' School, p. 147, 2012.
6. Ibid, p. 177.
7. Ibid, p. 178.
8. *Myths of Hindus and Buddhists*, Sister Nivedita, George. G. Harrap & Company, London, p. 2, 1913.
9. *The Web of Indian Life,* ch. V, Sister Nivedita, W. Heinemann, London, p. 198, 1904.

References:

1. Prabrajika Muktiprana, *Bhagini Nivedita,* 9th ed., Sister Nivedita Girls' School, 2012.
2. Sister Nivedita, *Hints on National Education*, 4th ed., Udbodhan Office, Kolkata, 1950.
3. Sister Nivedita, *Myths of Hindus and Buddhists*, George. G. Harrap & Company, London, 1913.
4. Shankari Prasad Basu, *Nivedita Lokomata*, volume 2, Ananda Publishers, Kolkata, 1987.
5. Sister Nivedita, *The Web of Indian Life*, W. Heinemann, ch. V, London, 1904.

গন্ধর্বের গান

অন্তরা ব্যানার্জী [a*]

[a] *Department of Sanskrit, Sister Nibedita Govt. General Degree College for Girls, Hastings House, Kolkata-700027*

ঋগ্বেদের যুগ আজ থেকে কমপক্ষে সাড়ে চার হাজার বছর আগের যুগ।[১] মন্ত্র এবং ব্রাহ্মণ, দু'য়ে মিলে বেদ।[২] মন্ত্রগুলি বিভিন্ন ঋষির রচনা, সংহিতার আকারে সংকলিত। ব্রাহ্মণ সাহিত্যে 'মন্ত্রের প্রয়োগ এবং তাৎপর্য' বিচার করা হয়েছে। ক্রিয়াসাপেক্ষে মন্ত্রগুলিকে তিনটি শ্রেণীতে ভাগ করা হয় — ঋক্ পদ্য, যজুঃ গদ্য এবং সাম গান। শ্রী অনির্বাণ বলেন, 'ঋক্সংহিতা মূলত গীতিকবিতার সংগ্রহ', 'গীতিকাব্যের প্রাচীনতম রূপ'। 'যাঁরা ঋক্ রচনা করতেন, তাঁরা শুধু কবি নন, 'স্তোতা' বা 'জরিতা' অর্থাৎ গায়ক। 'গীতিকবিতার সুপ্রাচীন নাম গাথা।'[৩] ঋক্বেদে গাথা এবং ঋক সমার্থক।[৪] ঋগ্বেদের অষ্টম মণ্ডলটিকে প্রগাথ মণ্ডল বলা হয়, এটি বিশেষভাবে উদ্গাতাদের গান করার উপযোগী মন্ত্রের সংগ্রহ। সামবেদ ঋক্পরবর্তী, কারণ যজ্ঞের প্রয়োজনে বিভিন্ন মন্ত্র সুরসহ এতে সংকলন করা হয়েছে। তবে সাম বা সুরের ব্যবহার মন্ত্ররচনার সময় অবশ্যই ছিল, এমনটাই মত শ্রী অনির্বাণের।[৫]

সামবেদের তিনটি শাখা। কৌথুম, রাণায়ণীয় এবং জৈমিনীয়। প্রথম দুটি শাখায় কিছু 'স্বরভেদ' ও 'পাঠভেদ' থাকলেও মন্ত্রে ভেদ নেই। তৃতীয় শাখাটিতে মন্ত্রসংখ্যা কম, গান বেশি। কৌথুম শাখার সামবেদে দুটি ভাগ — আর্চিক ও গান। ঋক্ বা মন্ত্রে সুর বসিয়ে গান হত, সুরটি সাম, আর ঋক্টিকে তার 'যোনি' (মূলগান) বলা হত। আর্চিক অংশে যোনিমন্ত্রগুলি এবং গান অংশে সেগুলির স্বরলিপি আছে। আর্চিকের আবার দুটি ভাগ—পূর্ব ও উত্তর। পূর্বার্চিক, আগেই বলা হয়েছে, যোনিমন্ত্রসংগ্রহ। যজ্ঞে সাধারণভাবে তিনটি ঋক্ বা তৃচ একটি সামে গাওয়া হত। প্রথমটি যোনি, বাকি দুটি উত্তরা। উত্তরার্চিকে সম্পূর্ণ তৃচটি দেওয়া থাকে। পূর্বাচিক সেক্ষেত্রে গানের সূচী বলা যায়।

ঋক্গুলি কোনো না কোনো ঋষির রচনা, অন্য কোনো ঋষি তাতে সুর যোজনা করেছেন। একাধিক ঋষি কোনো একটি মন্ত্রে সুর দিয়েছেন, এমন উদাহরণও আছে। গান অংশে চার রকমের গানের কথা আছে — গ্রামগেয়, অরণ্যগেয়, ঊহ এবং ঊহ্য। গ্রামগেয় গান সর্বসমক্ষে গাওয়া যেত। এই অংশে পূর্বার্চিকের প্রথম তিনটি কাণ্ডের স্বরলিপি আছে। বাকি অংশের স্বরলিপি আছে অরণ্যগেয় মানে। এটি নির্জনে গাইতে হয়। তৃচ অংশের স্বরলিপি ঊহ্য। ঊহ্য, যজ্ঞে গেয় রহস্যগানের স্বরলিপি।

সামবেদে সঙ্গীত কথাটির পরিবর্তে স্তোম, স্তোত্র, স্তোভ প্রভৃতি পারিভাষিক শব্দের ব্যবহার দেখা যায়। যেমন, তিনটি ঋক্ ফিরে ফিরে গাইলে তাকে স্তোত্র বলা হত। যতবার গাওয়া হত, তার সংখ্যার নাম স্তোম। গানের সুরে ঋক্টির যে পরিবর্তন ঘটে, তার নাম সামবিকার। ছ'টি সামবিকারের অন্যতম

* Corresponding author : Mob. No. : 9433181539, E-mail address : antara1775@gmail.com

ISBN : 978-81-933395-0-3

স্তোভ। এতে ঋকপ্রযুক্ত বর্ণগুলি ছাড়া অতিরিক্ত হাই, হাউ, ঔ, হোবা প্রভৃতি কিংবা অন্য পদ/বাক্য যোগ করা হত। প্রশস্তি পাঠ করার সময় উদাত্ত, অনুদাত্ত ও স্বরিত—তিনটি স্বর প্রযুক্ত হত। গান গাইবার সময় কিন্তু চার থেকে সাতটি পর্যন্ত স্বর প্রয়োগ করা হত।

প্রথম দিকে বড় বড় যাগ মহা সমারোহে অনুষ্ঠিত হত। সামবেদ ও যজুর্বেদের যুগে বড় যাগযজ্ঞের সঙ্গে সঙ্গে গৃহস্থের উপযোগী ছোট ছোট যজ্ঞের ব্যবস্থা হল। ছোট, বড় সব যজ্ঞেই সামগানের চল ছিল। এই সময় থেকে সামগানের পাশাপাশি আবিষ্কৃত হল গান্ধর্বগান। গান্ধর্বসঙ্গীতের সূত্র ধরে গন্ধর্ব, অপ্সরা, নাগ প্রভৃতির আবির্ভাব হয়। গন্ধর্ব নারদ, তুম্বুরু, বিশ্বাবসু, হাহা, হূ হূ প্রভৃতির উল্লেখ পাওয়া যায় মহাকাব্যে, পুরাণে[৬]।

প্রজ্ঞানানন্দের লেখা থেকে জানতে পারি, খৃঃ পূঃ ৫ম শতকে শিশুনাগবংশের রাজত্বকালে দেখা যায়, সামগানের প্রয়োগ ক্রমহ্রাসমান। কেবল রাজদরবারে এবং 'সাগ্নিক ব্রাহ্মণদের সমাজে' তার অনুশীলন হত। এসময় প্রবর্তিত হয় গান্ধর্বগান, 'যা সামগানোত্তর অথচ সামগানের গুণ ও প্রকৃতিধর্মী'। 'এর কৌলীন্য বৈদিক গানের মতোই ছিল' [৮]। বিম্বিসারের সময় পুরুষপুর বা পেশোয়ার ও রাওয়ালপিন্ডির সন্নিহিত এলাকা গান্ধার নামে কথিত হত। গান্ধারের অধিবাসী গন্ধর্বরা ছিল 'সঙ্গীতের আজন্ম সাধক'।[৯] তাঁদের প্রবর্তিত তৌর্যত্রিক বিদ্যাই ছিল গান্ধর্ব তথা বৈদিকোত্তর মার্গ সঙ্গীত। আচার্য ভরত একথা উল্লেখ করেছেন। নাট্যশাস্ত্রের শুরুতে ভরত বলেছেন, ব্রহ্মা রচিত নাট্যবেদ অনুসরণে তাঁর এই গ্রন্থ।[১০] মনে করা হয় আদি নাট্যবেদ ব্রহ্মারচিত। তিনি পিতামহ বা বৃদ্ধভরত নামেও খ্যাত। সামবেদ থেকে গান্ধর্বগান সংকলন করেছেন তিনিই। ভরত আরও বলেন, নাট্যবেদের প্রচারে সহায়তা করেছিলেন নারদ ও স্বাতি—দুই সঙ্গীতগুণী। স্বাতি সম্ভবত মৃদঙ্গাদি বাদ্যযন্ত্রে পারদর্শী ছিলেন। নারদের সম্পর্কে নানা উল্লেখ রয়েছে মহাকাব্যে, পুরাণে, বৌদ্ধ-গ্রন্থেও। প্রজ্ঞানানন্দের মতে, ইন্দ্র, ব্রহ্মা, ভরত প্রভৃতির মতো নারদও উপাধিবিশেষ[১১], গান্ধর্বশাস্ত্রে পারদর্শী ব্যক্তিকে সম্মানার্থে তাঁর নামে পরবর্তীকালে নারদ বলা হত। নাট্যশাস্ত্রে ২৮তম অধ্যায়ে ভরত গান্ধর্বগানের পরিচয় দিয়ে বলেছেন,

যত্তু তন্ত্রীগতং প্রোক্তং নানাতোদ্যসমাশ্রয়ম্।
গান্ধর্বমিতি বিজ্ঞেয়ং স্বরতালপদাশ্রয়ম্।।

বীণা প্রভৃতি বাদ্যযন্ত্র (বীণা প্রভৃতি তারের বাদ্য, বাঁশী/বেণু প্রভৃতি ফুৎকারবাদ্য, করতাল প্রভৃতি ঘন বা ধাতব বাদ্য এবং মুরজাদি অনিবদ্ধ বাদ্য) সহযোগে স্বর, তাল ও পদযুক্ত সঙ্গীত গান্ধর্ব নামে পরিচিত। গান্ধর্বের পদ নিবদ্ধ ও অনিবদ্ধ ভেদে দ্বিবিধ (না. শা. ৩২/২৫-২৬)। নিবদ্ধ গান তালযুক্ত, বিচিত্র ছন্দযুক্ত। অনিবদ্ধ তালহীন আলাপ, তবে এতে ছন্দ ও যতি থাকে। নাট্যশাস্ত্র খৃষ্টীয় ২য় শতাব্দীতে লেখা। তাঁর সময়ে প্রচলিত গীতিপ্রয়োগের বিবরণ দিয়েছেন নাট্যশাস্ত্রকার। নাটকে রঙ্গমঞ্চের বাইরে মাগধী বা অর্ধমাগধী চিত্রকলার সাহায্যে প্রযুক্ত হত।[১২] মাগধী মগধ দেশে বা বিদর্ভদেশে উদ্ভূত। এইগুলি অভিজাত দেশী গান। গান্ধর্বে এ জাতীয় দেশীগানের চল আছে।

খৃষ্টপূর্ব এবং খৃষ্টীয় শতকের গোড়ার দিকে নিবদ্ধ ও অনিবদ্ধ দু'ধরণের গান্ধর্বগান প্রচলিত ছিল। সঙ্গীতরত্নাকরে ৪র্থ অধ্যায়ে শাঙ্গদেব গন্ধর্বের এই বিবর্তন ব্যাখ্যা করেছেন—

অনাদিসম্প্রদায়ং যদ্ গান্ধর্বৈঃ সংপ্রযুজ্যতে।
নিয়তং শ্রেয়সো হেতুস্তদ্‌গান্ধর্বং জগুর্বুধাঃ।।
যত্তু বাগ্‌গেয়কারেণ রচিতং লক্ষণান্বিতম্।
দেশীরাগাদিযু প্রোক্তং তদ্‌গানং জনরঞ্জনম্।।

অর্থাৎ, অনাদিকাল থেকে গুরু শিষ্য পরম্পরায় যে গানের অনুশীলন হয়ে আসছে এবং যা নিয়ত কল্যাণকর, তাকে গান্ধর্ব বলা হত। অন্যদিকে, বাগ্‌গেয়কারেরা বা শিল্পীরা যে দেশীয় সুর বা রাগগুলিকে অভিজাত শ্রেণীভুক্ত করে নিয়েছিলেন, তাকে 'দেশী' সঙ্গীত বলা হয়। প্রজ্ঞানানন্দের মতে, "প্রাচীন ভারতের

গান্ধর্বগানই পরবর্তীকালে পরিবর্তিত আকারে ও উপাদানে দেশী গান বলে পরিচিত হয়। ... দেশী সঙ্গীত গ্রাম্য বা আঞ্চলিক (folk music) নয়, তা শাস্ত্রীয় ক্লাসিক্যাল শ্রেণীভুক্ত গান বা সঙ্গীত" [১৩]।

ঐতিহাসিকরা বলে থাকেন, রামায়ণের রচনাকাল খৃঃ পূর্ব ৪র্থ শতক। রামায়ণে পাওয়া সাংগীতিক বিবরণ থেকে গান্ধর্বগানের কিছু পরিচয় পাওয়া যায়। আচার্য ভরত পূর্বসূরীদের নামের যে তালিকা দিয়েছেন, সেখানে রামায়ণকার বাল্মীকির নামও করেছেন। রামায়ণের যুগে বৈদিক সামগান ঋত্বিক ও সামগ ব্রাহ্মণদের মধ্যে সীমায়িত হয়েছিল। অভিষেক, আশীর্বচন, স্তুতিগান প্রভৃতি অনুষ্ঠানে অবশ্য সামগান হত। গান্ধর্ব বা মার্গসঙ্গীতকে কিষ্কিন্ধ্যাকাণ্ডে 'সঙ্গীত' বলা হয়েছে (কিষ্কিন্ধ্যা ২৮/৩৬-৩৭)। সঙ্গীত গীত, বাদ্য ও নৃত্যের সমুচ্চয়। বালকান্ডে সাতটি শুদ্ধ জাতিগান এবং সুন্দরকাণ্ডে কৈশিক গ্রামরাগের কথা আছে। অযোধ্যাকাণ্ডে পাণিবাদক সূত, আশীর্গান ও গাথাগানের উল্লেখ আছে। সূত ও ভাটজাতীয় পাণিবাদকরা (যারা হাততালি দিয়ে গান করত) রাজার বেতনভুক কর্মচারী, এরা স্তুতিগান গাইত সুরে তালে। বেদজ্ঞ ব্রাহ্মণরা বীণা বেণু প্রভৃতি বাদ্যযন্ত্রের সঙ্গতে আশীর্গান ও গাথাগান করতেন। এই ধরণের মাঙ্গলিক গান গান্ধর্বশ্রেণীভুক্ত ছিল। বালকাণ্ডে ১৪শ সর্গে বেদজ্ঞ ব্রাহ্মণগণ ঋষ্যশৃঙ্গ মুনিকে সামনে রেখে 'মধুর স্নিগ্ধ গীতি' দ্বারা যজ্ঞে আহুতি প্রদান করেছেন। গানের কথার উচ্চারণভঙ্গী (৪/১১, বালকান্ড), শিল্পীদের সুন্দর বেশভূষা (৩/৪/১১) প্রভৃতির দিকে নজর দেওয়া হত। গানকে 'গেয়' এবং শিল্পীকে বলা হত 'গায়ক'। উত্তরকাণ্ডে ৯৩-৯৪ সর্গে বাল্মীকি কুশী ও লবকে বলেন, 'বৎস, তোমরা আশ্রমে, ব্রাহ্মণগৃহে, রাজপথে, রাজগৃহে, রামচন্দ্রের প্রাসাদের দ্বারে, যজ্ঞস্থানে রামায়ণ গান গেয়ে বেড়াও।' শুদ্ধ উচ্চারণে, বীণাযোগে, দ্রুত, মধ্য ও বিলম্বিত লয়ে তারা গান গেয়েছিল, যা শ্রোতাদের আনন্দবর্ধন করেছিল। কুশীলবের প্রশংসা করে বাল্মীকি বলেছেন, তারা দুটিতে গন্ধর্বের মতো সুন্দর (গন্ধর্বাবিব রূপিণৌ)। কাব্যের বিচিত্র রস গানের মধ্যে দিয়ে পরিবেশন করার সময় কণ্ঠে যে ধ্বনিবৈচিত্র সম্পাদিত হয়, তাকে কাকু বলে। বাল্মীকি কাকুস্বরের রহস্য শিক্ষা দিয়েছিলেন কুশীলবকে।

লক্ষ্য করার বিষয়, অযোধ্যাকাণ্ডে, সুন্দরকাণ্ডে ও কিষ্কিন্ধ্যাকাণ্ডে সঙ্গীতবিষয়ে দু'চার কথা থাকলেও তা এসেছে প্রধান চরিত্রগুলির বা মূল বিষয়ের অনুষঙ্গ রূপে। বালকাণ্ড এবং উত্তরকাণ্ডে বিশেষভাবে গান্ধর্ব ও গানের কথা আছে, কোথাও বা গানই বক্তব্য বিষয় হয়ে উঠেছে। যেমন, বালকাণ্ড ৪, ১০ বা ১৪শ সর্গে, উত্তরকাণ্ড ৯৩-৯৪ সর্গে, ৭১ সর্গে। বালকাণ্ডে ক্রৌঞ্চমিথুনের একটিকে ব্যাধ যখন বধ করে, তখন শ্লোকের আকারে বাল্মীকির মুখ থেকে নির্গত হয় বেদনার অভিব্যক্তি। নিজের উচ্চারণে বিস্মিত কবি বলে ওঠেন — কিমিদং ব্যাহৃতং ময়া। চারটি চরণে নিবদ্ধ, সমাক্ষর, লয়যুক্ত এই রচনা তন্ত্রী বা বীণার সঙ্গে গানও করা যায়। উইন্টারনিৎস, হোলট্‌ম্যান প্রমুখ মনে করেন বর্তমান আকারের রামায়ণ চারণসম্প্রদায়ের মুখে মুখে প্রচলিত রামায়ণ গান অবলম্বনে রচনা করেছিলেন বাল্মীকি[১৪]। বালকাণ্ড ও উত্তরকাণ্ড খৃষ্টাব্দ শুরুর সময় রচিত হয় বলে অনুমান। রামায়ণ রচনা শেষে কুশীলব সুরতান সহযোগে রামগাথা গান করে বেড়াতেন, তা বলা হয়েছে। সম্ভবতঃ আঞ্চলিক বা 'চলিত' 'কথ্য' ভাষায় এই পৌরাণিক কাহিনী বাল্মীকির সময়েই জনপ্রিয় ছিল। বাল্মীকি সেই পুরোনো কাহিনীকে রূপ দিয়েছিলেন পরিশীলিত 'সংস্কৃত' ভাষায়, যা বৈদিক ভাষা থেকে অনেকটাই আলাদা, আবার বৌদ্ধ মিশ্র সংস্কৃত বা পালিভাষা থেকে অনেকটাই পরিশুদ্ধ একটি ভাষা। সামগান থেকে গান্ধর্বগানে বা মার্গসঙ্গীতে বিবর্তন তাঁর আগেই হয়েছিল, তিনি দেশজ সুরের আত্মীকরণ করে 'সংস্কৃত' ভাষায় রচনা করলেন কবিতা বা পাঠ্য, যা তাঁর সময়েই রূপ নিল গানে (গেয়), উত্তরকাণ্ডে সেই ছবি স্পষ্ট হয়ে ধরা পড়েছে। এই গান গান্ধর্ব বা মার্গ সঙ্গীতের একটি বিবর্তিত রূপ। একে অভিজাত বা 'দেশী' আখ্যা দেওয়া হয়েছে।

শিক্ষাকার নারদ বৈদিক ও লৌকিক দু'রকম সঙ্গীতের পরিচয় দিয়েছেন। ভরত অবশ্য নাট্যবস্তুর রূপায়ণে গান্ধর্বগানের বিষয়েই আলোচনা করেছেন। খৃষ্টীয় ২য় শতক প্রজ্ঞানানন্দের মতে গান্ধর্বগানের

'সায়াহ্নকাল'[১৫]। ভরতের সময় (খৃঃ পূঃ ১ম-১ম শতাব্দী) জাতিরাগ ও গ্রামরাগগুলি রসভাবসমন্বিত হয়ে শাস্ত্রীয় মর্যাদা (গান্ধর্বপদবী) লাভ করেছিল। ২য় শতকে কোহল, শাণ্ডিল্য প্রভৃতির সময়ে দেশী সংস্কৃত সঙ্গীতের জনপ্রিয়তা বৃদ্ধি পায়। ৬ষ্ঠ শতকে, গুপ্তযুগে বৈদিক ও গার্ন্ধবগান লুপ্ত হয়েছিল। পরিবর্তে মার্গধরনের দেশীয় ও জাতীয় সুর অভিজাত 'রাগ' মর্যাদায় প্রতিষ্ঠা লাভ করে।

বৈদিক সামগানের সঙ্গে সঙ্গে নারদ, তুম্বুরু, বিশ্বাবসু, চিত্রসেন প্রভৃতি গন্ধর্বের প্রচারিত গন্ধর্ব সঙ্গীত গৌরবের আসন লাভ করেছিল। সম্ভবত এ দুটি সঙ্গীতধারা সমসাময়িক। সামগান সামগ ও ঋত্বিকসমাজে প্রচলিত, গান্ধর্ব গন্ধর্বদের সমাজে প্রিয়। তবে গন্ধর্বরা নানা বিষয়ে বৈদিক সঙ্গীতের কাছে ঋণী।[১৬] বাল্মীকি রামায়ণে যে গান্ধর্বগানের কথা আছে, তা বস্তুত মার্গসঙ্গীত, বৈদিক ও গান্ধর্বমার্গের অনুগামী। পুরাতন গান্ধর্ব সঙ্গীত তখন কেবলমাত্র আশীর্বাদসূচক ও মাঙ্গলিক স্তোত্রাদিতে ব্যবহৃত হত। তবে জাতি বা গ্রামরাগ আশ্রিত নতুন ধরণের গান (বাল্মীকির রামায়ণ গানও এর অন্তর্গত) গান্ধর্ব শ্রেণীভুক্ত বলেই কথিত হত তখনো।[১৭] এজন্য টীকায় গান্ধর্বকেই মার্গসঙ্গীত বলা হয়েছে বারবার (সঙ্গীতরত্নাকর ও তার টীকা, ভাষ্য)। অন্তত ভরতের সময়েও গান্ধর্বসঙ্গীতে ব্যবহৃত গান্ধারগ্রাম ও গান্ধর্বগীতিপদ্ধতি সম্পূর্ণ লুপ্ত, তার স্থান নিয়েছে মার্গসঙ্গীত বা অভিজাত দেশীসঙ্গীত। 'আঞ্চলিক দেশী' বা folk song গুলি গান্ধর্বোত্তর হলেও কোনো না কোনো আকারে দেশী সুরগুলির পূর্ববর্তীরূপ গান্ধর্বরীতির উদ্ভবের কারণ হয়েছিল। বৌদ্ধযুগে ভারতে মালব, পাঞ্চাল, কুরু, গান্ধার, চেদী, মদ্র, শালব, আভীর, কেকয়, নিষাদ, লিচ্ছবি, শবর, চোল, বঙ্গ, গৌড়, পুন্ড্র, কিরাত, দশার্ণ প্রভৃতি জাতি নিজস্ব ধারায় নৃত্য গীতাদির অনুশীলন করত। সেই জাতিগুলির সুর পরবর্তীযুগে অভিজাত দেশীসঙ্গীতে 'রাগ' হিসেবে গণ্য হয়েছিল। যেমন, শবরী বা সাবেরী, আভীরী, গৌড়, গান্ধারী, পুলিন্দিকা ইত্যাদি[১৮]। স্বামী প্রজ্ঞানানন্দও যাবতীয় বিবর্তনের মধ্যে অপরিবর্তিত একটি অবিচ্ছিন্ন সুরের অস্তিত্ব স্বীকার করেছেন।

সামগান থেকে গান্ধর্ব বা গান্ধর্ব থেকে দেশীসঙ্গীতে বিবর্তনের মূল প্রয়োজনটি ভাষাগত। যে সময়ের মানুষ যে ভাষায় কথা বলেন, সেই ভাষাই হয়ে ওঠে তার কবিতার ভাষা, গানের ভাষা, ভাবনার ভাষা। বেদ পরবর্তী সমাজে রাজাদের সভায় যে কবিরা গান বেঁধেছেন, সুরে তালে যে অপ্সরাবৃন্দ নৃত্য ও নাট্য পরিবেশন করেছেন, তাঁরা কেউই কল্পজগতের অধিবাসী নন, রক্তমাংসের মানুষ। বৈদিক ভাষা থেকে ধ্রুপদী সংস্কৃতে প্রসরণশীল একটি সংস্কৃতির চিহ্ন বহন করছে তাঁদের গান্ধর্বগান। সেই সঙ্গীতের, সেই কৃষ্টির ধারক ও বাহক ছিলেন নারদাদি সঙ্গীতশাস্ত্রী। রাজারা ছিলেন তাদের পৃষ্ঠপোষক। ঊর্বশী, মেনকা প্রভৃতি অপ্সরাগণ রাজদরবারের নর্তকী, যাঁরা সঙ্গীতের অনুশীলন এবং প্রদর্শন করে এসেছেন আজীবন। বৈদিক সভ্যতার সন্ধ্যাকালে শিল্পচর্চার নতুন ধারা প্রবর্তিত হয়েছে এঁদের হাত ধরে। এ কারণে ধ্রুপদী সভ্যতার 'ইতিহাসে'—রামায়ণ, মহাভারত ও পুরাণগুলিতে এঁদের কথা উঠে এসেছে বারবার।

পাদটীকা ঃ

১। পৃঃ ৩১০, History of Indian Literature, Vol. 1, Winternitz

২। আপস্তম্ব শ্রৌতসূত্র ২৪/১/৩১

৩। পৃঃ ৫৮, বৈদিক সাহিত্য (১ম খণ্ড) অনির্বাণ

৪। পৃঃ ৫৯, ঐ

৫। পৃঃ ৫৯ ঐ, পাদটীকা

৬। পৃঃ ২২৯, ভারতীয় সঙ্গীতের ইতিহাস (২য় ভাগ), প্রজ্ঞানানন্দ

৭। পৃঃ ৫৫, ঐ

৮। পৃঃ ৫৪, ঐ

৯। পৃঃ ৫৫, ঐ

১০। ১/১, পৃঃ ১, ভরত নাট্যশাস্ত্র, বন্দ্যোপাধ্যায়

১১। পৃঃ ৬১, ভারতীয় সঙ্গীতের ইতিহাস, ঐ

১২। পৃঃ ২৪৯, ঐ

১৩। পৃঃ ২৫৭, ঐ

১৪। পৃঃ ৭৫, ঐ

১৫। পৃঃ ৪৫৮, ঐ

১৬। পৃঃ ৪০৭, ঐ

১৭। পৃঃ ৩২০, ঐ

১৮। পৃঃ ২২০, ঐ

১৯। পৃঃ ৫২, বৈদিক সাহিত্য, অনির্বাণ (১ম খণ্ড)

গ্রন্থপঞ্জী ঃ

১। অনির্বাণ, বৈদিক সাহিত্য (১ম খণ্ড), সংস্কৃত বুক ডিপো, কলকাতা, ২০০৬

২। আলতেকর, এ. এস, The Position of Women in Hindu Civilization, MLBD, Delhi, 2016

৩। দত্ত, রমেশচন্দ্র, ঋগ্বেদসংহিতা, সদেশ, কলকাতা, ২০০৭

৪। বন্দ্যোপাধ্যায়, সুরেশচন্দ্র, ভরতনাট্যশাস্ত্র, নবপত্র প্রকাশন, কলকাতা, ২০১৪

৫। স্বামী প্রজ্ঞানানন্দ, ভারতীয় সঙ্গীতের ইতিহাস (১ম ও ২য়), শ্রীরামকৃষ্ণ বেদান্তমঠ, কলকাতা, ২০১১

৬। Winternitz. M., History of Indian Literature (Vol. 1), Calcutta University, 1927।

150th Birth Anniversary Celebration

PERSONIFICATION OF NATURE THROUGH THE VARIOUS ATTRIBUTES OF VEDIC GODDESSES

Jayanta Nandi [a*]

[a] *Department of Sanskrit, Sister Nibedita Govt. General Degree College for Girls, Hastings House, Kolkata-700027*

Abstract

From the ancient period, the nature is worshiped as God. On those days when the people faced any kind of natural disaster they worshiped the multifarious elements of nature as deity. In this way Vedic Varuṇa was the deity of rain, Indra, the deity of thunder, Pavana, the deity of the windstorm, like so many deities were idolized. Now, in present days also, worship of nature is shown. Not only the deity (Deva), but also our goddess (Devī) of natural abundance and fortune were worshiped by the people in the Vedic era. In the Vedic literature when we carefully observe the early Saṁhitā texts, few goddesses are regarded as the goddess of wealth and fortune. These goddesses are Aditi, Purandhi, Rākā, Dhisana and Śinivāli. In the Ṛgveda and Atharva Veda, Aditi is identified with the earth. The present paper is going to focus on more about these goddesses how they were personified of nature, through the light of the Vedic texts.

Keywords : Nature; Deity; Ṛgveda; Goddess; Devī

It is a common belief in Brahmanical pantheon that the prevalence of Śakti worship or 'Devī-pūjā' was so later than the worship of the Gods or 'Deva-Pūjā'. But this view is not correct. From the archeological evidence it is proved that the prevalence of Śakti-worship began from the very early period of our history. So many archeological objects which help us to prove that the prevalence of śakti-worship existed in some from or other among the early Indus Valley people. In this connection Marshal remarks, 'Śakti-worship' was of great antiquity in India, it originated out of the cult of the Mother Goddess, and it was closely connected with the cult of Siva" (Marshal, Mahenjodaro and the Indus civilization, Vol.1, p.57) In the Vedic literature when we carefully observe the early Saṁhitā texts, Śakti worship or 'Devi pūjā' was present there. Few goddesses like Aditi, Purandhi, Rākā, Dhiṣāṇa, Uṣās and Śinivāli, represent a personification of nature.

The Vedic deities are considered as the personification of the natural forces. The Ṛgveda which is the most ancient of the four Vedas contains mantra (prayers), addressed to deities such as Indra, Agni, Varuna, Soma, and others who are obviously

* Corresponding author : Email: jayantand41@gmail.com, Phone: 9163141552

ISBN : 978-81-933395-0-3

the religious transformation of different natural phenomena. The empirical and metaphysical aspects of Vedic deities are clearly observable in their descriptions. The concept of deities has two dimensions, the natural or physical aspect that could be realized through senses and the personified aspects that are imaginative or mythical. A brief description of important natural forces personified in the Vedas is given bellow.

Like the great mother goddesses in the Indus Valley civilization Aditi took prominent part in the Vedic literature. We have seen that the goddess Aditi is not the subject of any separate hymn, but is often incidentally celebrated in the Ṛgveda. We have seen her name about eighty times in the Ṛgveda. It is said that Aditi is bright and luminous, a support of creatures. (Ṛgveda, 1, 136, 3) In the Ṛgveda Aditi is known as mother of Mitra, Varuṇa (Ṛgveda, 8, 26, 3) and also the mother of king. (Ṛgveda 8, 26, 3) In the Ṛgveda and Atharva Veda, Aditi is identified with the earth. (Atharva Veda, 13, 1, 38, Ṛgveda , 72, 9) The much celebrated mother of the gods, Aditi is the infinite and the womb of the cosmos. In one important passage Aditi represents a personification of Universal Nature. Here she is described as

Aditirdauraditirantarikshamaditirmāta
Sa pitā sa putra
VisvedebāAditi Panchaya
Aditirjtāamaditirjanitvam. (Ṛgveda, 1, 89, 10)

Aditi is the sky; Aditi is the air; Aditi is the mother and father and son; Aditi is all the gods and the five tribes; Aditi is whatever has been born; Aditi is whatever shall be born. In some passage of the Ṛgveda and other Saṁhitās she is regarded as a cow. (Ṛgveda 1, 153, 3; 8, 90, 15; 10, 11, 1) and in the ritual the ceremonial cow is addressed as Aditi. This characteristic indicates the boundless plenty and she is identified as boundless earth, heaven and universe. In one place of Taittirīya Saṁhitā she is described as the heavenly lady of quarter, the easily milked, the rich in milk, the goddess…the lady of Viṣhṇu, the mild, ruling the world…May Aditi be auspicious to us. (Taittirīya Saṁhitā 4, 4, 12) Thus Aditi, a personification of nature as the great mother and as a lady of abundance, presents close analogies with Śri-Lakshmī as a goddess of fertility and wealth.

Dhiṣāṇa is a goddess of abundance in the Rgvedic time. (Ṛgveda 46, 120, 22) Dhisana is the earth (in the dual, heaven and earth; in the plural, heaven, air and earth). According to pischel singular Dhiṣāṇa is everywhere interpreted as proper name, the name of the goddess of wealth and prosperity. The dual Dhiṣāṇa means 'Heaven and Earth' the goddess of wealth originally was a goddess of earth conceived as the liberal giver of wealth. Rākā is mentioned in the Ṛgveda as rich and bountiful goddess. (Ṛgveda 2, 33, 7; 5, 49, 10) In the later Vedic texts Rākā and Śinivāli are connected with the different phases of the moon, the former being the presiding deity of the actual day of the full moon night (pūrṇimā) and the latter, the same of the new moon light (amāvasyā).

The image of the earth as a goddess, known variously as Pṛthivī, Dharaṭimātā, Jagadhātrī is ancient and all-pervasive. Almost all the geographical features of the natural environment are personified as goddesses. Mountains, caves, rocks, forests, trees, plants, healing herbs, rivers, streams, lakes were conceived of as potent symbols of feminine power, inherent in nature. From the Vedas down to the Puraṇ as

nature personifications are mediated through the symbol of the divine feminine. In the Ṛgveda, for example, the crimson streak of day-break is portrayed as Uṣas, the Mistress of Dawn whose brilliant effulgence spreads out piercing the formless black abyss (Ṛgveda, 10.127). Night and day are the two celestial sisters that bring rest and awakening to the world. In their lap, gods recline and enact their roles.

The Vedic seers viewed Earth and Sky together as a single principle (Dyāvāpṛthivī) that gives life to all beings. Sky is the father and earth is the mother of all. Both are shinning and the base for all the creation. They are eternal and specially held by Varuna in their proper places. (Ṛgveda. 5.70) Another mantra in Ṛgveda prays earth and sky to provide food, force and wealth. Father sky produces rain and mother earth bears all beings. They know everything and are always active. They are happy to co-operate with each other and treat everybody equally.

The rivers Gangā, yamunā and Sarasvatī mentioned in the Vedas are goddesses who preside over the enriching waters of life. The hymn dedicated to Araṇyanī (Ṛgveda, 10.146) or the forest goddesses (Vanadevīs) celebrated the spirit of the forest and groves. They are joined by an innumerable number of goddesses who preside over village territories and specific sacred centers (Kṣhetradevīs). The life sustaining foods also have their goddesses in the personifications such as, Annapurna. Thus from the sky wandering celestial bodies to the sprouting plant were conceived of as an exposition of the feminine principle. The Vedic seers were moved by the beauty and splendor of the far spreading earth. The earth holds the verdant continents, lands with forests, nurtured by abundant rains and simmering warmth. Her body laced by rivers, rimmed by ocean is adorned with "gentle slopes and plains" (Atharva Veda, 12-1.2). The earth is composed of hills, 'rock, stone and dust' and is compactly held. An essential feature of the Earth is her fragrance which pervades all the products of the earth. The herbs, water, nymphs and celestial creatures bear it. Her fragrance enters the lotus and the flowers everywhere. May this fragrance enter him, says the seer:

> Instill in me abundantly that fragrance,
> O Mother Earth, which emanates from you
> Your fragrance which has entered the lotus
> Where with the immortal Gods at the Sun-daughter's wedding
> Was redolent, O Earth, in times primeval —
> Instill in me that fragrance.
> Your fragrance that adheres to human beings
> O Earth, steep us, too deeply in that fragrance. [Atharva Veda, 12.1.23-26]

The goddesses association with the waters of life is perennial. There is an enormous amount of material to show the antiquity and popularity of the intimate connection of the goddess with the waters. The Mahabharata (VI.10-35) invokes all the rivers as 'Mothers of the World'. In the Rg Vedic hymn, the waters, referred to as Apaḥ appear as goddesses, young maidens and wives, and life-sustaining mothers, of Agni. The rivers also appear as independent goddesses (Saptasindhavaḥ). All the rivers of India that meander through the land, plains and hills embody as the fecundating element that renews life. An early invocation celebrated the river goddesses: The waters of the sky or those that flow (on earth), those that are dug out, or those that arise from themselves, those pure and clear waters that seek the ocean as their goal — Let the waters, who

are goddesses, help me here and now. (Ṛgveda, 7, 49.2)The texts categorically assert that there are innumerable rivers and that all are uniformly divine. They are said to have sprung from the celestial rivers that dwell in the form of clouds and rain in the atmosphere. The celestial river of sacred waters spring from it (the Moon), the reservoir of nectar. The river of clear transpresent water flows through the sky through the path of the wind (on earth) (Vayu Purāṇa, 43. 2-3). The waters wash away the impurities. They are pregnant with healing, life-giving and purifying properties: May the waters purify us; clarifiers of ghee, may they clean us with ghee, for the goddesses carry off impurity. [Ṛgveda, 10.17.10]

In the Samhitas we can observe that people established a direct connection with nature. Personification of natural phenomena is clear. They prayed natural forces and sought their help to have a prosperous life. Vedic mythology presents to us an earlier stage in the evolution beliefs based on the personification and worship of natural phenomena than any other literary monument of the world. The earliest stage of Vedic mythology is not so primitive to enable us to which natural phenomena developed into gods a process not apparent in other literature. The true gods of the Veda are glorified human beings inspired immortal. They are almost without exception the deified representatives of the phenomena or the agencies of nature.

References:

- J. Gonda, The Duel Deities in the Religion of the Vedas, Amsterdam, 1974.
- P. K. Agarwala, Goddesses in Ancient India, Abhinav Publications, 1st Ed. New Delhi, 1984.
- N. N. Bhattacharya, 'Earth and Woman' in Ancient Indian Rituals and their Social Contents, Manohar Book Services, N. Delhi, 1977.
- Rgveda, Samhita and pada text with Sayana's comm. Edited by F.Max Muller, 1980 (Translation by Max Muller) SBE.Vol.XXXII, Oxford, 1891, and H.Oldenberg, SBE. Vol.XLVI, Oxford, 1898 by A.Welber, Berlin, 1871.
- Vayu Purana, Edited by Panchanan Tarkaratna,Calcutta, 1317 B.S.
- N. N. Bhattacharya, Indian Mother Goddess, Manohar Book Services, N. Delhi, 1977.
- Cheever Mackenzie Brown, God as Mother: A Feminine Theology in India, Hartford, Claude Stark & Company, 1974.
- Moti Chandra, Studies in the Cult of Mother Goddess in Ancient India, No.12, 1973.
- Dowson, J. A Classical Dictionary of Hindu Mythology and Religion, Geography, History and Literature, Trubner & Co.London, 1888
- Wangu, M. B. Images of Indian Goddesses, Abhinav Publications, New Delhi, 2003.
- Ochshorn, Judith; 'Gender and the Nature of the Divine: The Polytheistic View', in the Female Experience and the Nature of the Divine; Indiana University Press, Bloomington, 1981.

150th Birth Anniversary Celebration

THE OTHER ASPECT OF COAL: ISOLATION OF GRAPHENE BASED MATERIALS AND IT'S USE TO DELIVER DRUG IN BRAIN

Bholanath Pakhira [a,b] and Sabyasachi Sarkar [b*]

[a]*Dept. of Chemistry, Sister Nibedita Govt. General Degree College for Girls, Hastings House, Kolkata-700027*

[b]*Nano Science and Synthetic Leaf Laboratory, IIEST, Shibpur, Botanic Garden, Howrah-711103*

Abstract

To deliver drug in the brain is a serious challenge because of the existence of the blood brain barrier (BBB) which separates blood vein from the brain and the central nervous system (CNS). Here in this work we describe the passage of Grapene Oxide (GO) soluble (not dispersed) in Phosphate buffer (pH 7.4), synthesized form low grade coal, in the brain of laboratory animal. With the passage of time these fluorescent water soluble GO once inside get gradually excreted out from the body and thus its provide a very convenient source to carry any important molecule or drug inside as we have already shown in our previous work that it can encapsulate large molecule like tetraphenyl porphyrin (TPP) which is a generic used in photo dynamic therapy. We also encapsulate Donepezil, a well known drug for Alzheimer disease in this work. Thus it can be used in several probes in accelerating such investigation to assist Alzheimer's Parkinson's or brain tumour patients as it solve the purpose of deliver the market available drug in the brain crossing so called BBB.

Keywords: Low grade coal; Graphene oxide; BBB; Drug delivery; Alzheimer; Parkinson's disease.

Introduction

Coal[1] is abundant and easily combustible energy resources that being used in third world country like India. Based on the carbon contains, coal has been graded in various types where maximum carbon percentage is being considered as higher grade whereas lowest carbon contains is low grade[2]. It is well known to us that Humus at very high pressure and temperature under the earth converted to coal and finally when all hydrogen is removed it is turned into graphite[3,4]. So in low grade coal, there is a possibility of existence of intermediate graphene oxide (GO). So can we develop a very cheap and environmental friendly approach to synthesize graphene oxide[5] (size more than

* Corresponding author: Email: abya@iitk.ac.in

ISBN : 978-81-933395-0-3

conventional quantum dots[6] and less than large graphene oxide flakes synthesized form graphite powder using vigorous oxidation using Hummers method[5]) from low grades of coal using alkali treatment if we can control the unique nature of open and close sesame of this isolated GO that will be potentially opens new doors for drug delivery.

Overcoming the issue of delivering therapeutic agents to specific regions of the brain presents a significant challenge to treatment of most brain disorders. In its neuroprotective role, the blood–brain barrier functions to hinder the delivery of the many probably necessary diagnostic and therapeutic agents to the brain. Therapeutic molecules and antibodies which may be well effective in identification and medical aid don't cross the blood brain barrier (BBB)[7] in adequate amounts. The perivascular cells in a brain play an important role of selective permeable space between the blood circulatory system and central nervous system which is commonly known as the BBB[7]. It is composed of endothelial cells, pericytes and astrocytes and it protects the functionality of the brain and central nervous system(CNS). Pericyte[8] cells create the BBB with tight junctions to protect vesicle trafficking through the endothelial cells and inhibit the effects of CNS immune cells and pericytes as contractile cells also contribute to controlling the flow within blood vessels as well as between blood vessels and the brain[9].

We have already shown that GO is nontoxic to human[10] as we have being using GO through food, barbeque, medicine. Further it is self fluorescent. Based on these utilities we further probed the use of small size GO to cross the BBB and to reach the brain.

Experimental

Synthesis of GO: Low grade powdered form coal was first freed from aromatic hydrocarbons and other soluble organic compounds by repeatedly washing with acetone using Soxhlet apparatus followed by dilute hydrochloric acid to free these from inorganic oxides and finally washed with distilled water and dried in air. The dried powder coal (5.0 g) was treated with concentrated nitric acid (50 mL) in portion to avoid excessive heat generation wherein the release of brown fumes started and finally that died down. The mixture was allowed to stand overnight at room temperature. It was neutralized with NaOH. This solid was dissolved in ethanol and the alcoholic solution was evaporated to dryness under vacuum at lower temperature to yield a brownish yellow mass of 1.7g. However with time this sample lost water solubility. This can be made soluble in 10% sodium hydroxide solution to get a yellow-brown colour solution. This solution after filtration and then slowly neutralized with dilute hydrochloric acid to pH 7 and on standing a brown colour flaky precipitate appeared. This precipitate was separated out by centrifugation, washed with cold water to free it from sodium chloride formed in the neutralization process and finally dried in air yielding a red brown solid with almost quantitative yield based on the weight of the source material used. This solid is subjected to several spectroscopic and microscopic analyses and also by FTIR to show that this is a new form of GO.

Mice study : 1 mg/ mL of such small size GO isolated from coal in water was made and 10.0 ul per gm of the body weight of mice was administered by intravenous tail vein injection. 6 to 8 months old transgenic FVBN mice[11,12] (R169C; Tg88by over expression of mutated transgene) (23 to 26 g) was used that was obtained from either

Charles River (Kisslegg, Germany) or Jackson Laboratories (Bicester, UK). The animals had free access to tap water and pellet food. Mice within one experiment were housed individually throughout the experiment. We imaged the brain in vivo with the progress of time using tail vain injection of GO. Images were taken by constant monitoring for at least 30 minutes after injection of GO after taking few baseline images along with control subject. The mice were then sacrificed and their brain slice was imaged by fluorescence microscopy using two colour channels, red fluorescent GO and green fluorescent lectin. Mice excreta were analyzed using fluorescence spectroscopy. First mice (treated and control) excreta were dried under vacuum then grinded and dissolved in PBS buffer pH 7.4. Then the fluorescence spectra recorded it was repeated for three different mice excreta.

Donepezil –GO composite : 5 ml alcoholic solution of 2 mg GO was mixed with a DCM solution 5 ml of 5 mg Donepezil[13] and the mixture was evaporated in cold at -37°C under vacuum. The resultant residue formed was washed thrice with water containing very dilute hydrochloric acid (pH~4) to remove any unwrapped DZ and finally with water and dried in vacuum to get pure GO-DZ composite. These composites were then subjected to various spectroscopic and microscopic investigations as described in the result section.

Results

Electronic spectra (Fig. 1: a) in PBS buffer shows typical graphene oxide spectra with small peak around 270 nm while the atomic force microscope (AFM) (Fig. 1: b) and tunnelling electron microscope (TEM) (Fig. 1: c) study shows spherical dot like shape

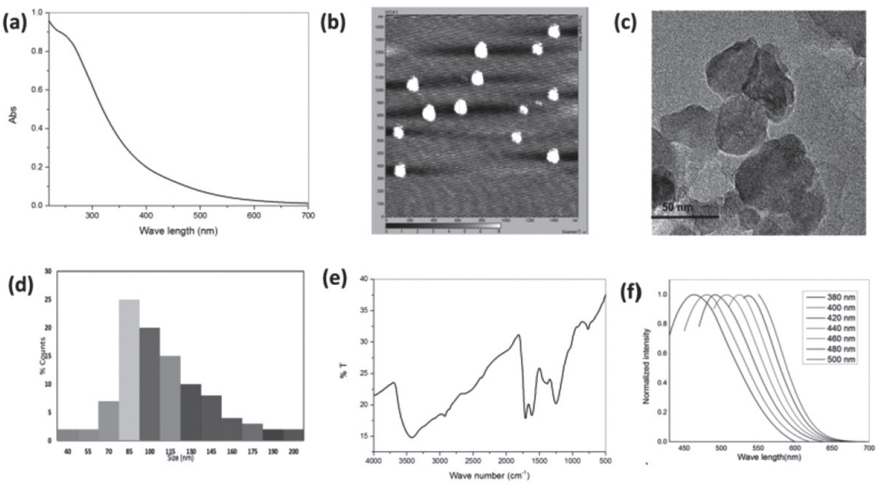


Fig. 1: Characterization of synthesized GO: (a) Electronic spectra in PBS bugger (pH 6.8), (b) AFM image and (c) TEM image showing spherical particle of GO (d) DLS showing different size distribution, (e) FTIR spectra and f) Fluorescence spectra of GO in PBS buffer.

with average size 50 nm. DLS (Fig. 1: e) spectra shows distribution pattern from range of 40 nm to 200 nm while IR shows C = O (~1700 cm^{-1}) and C-O-C (epoxide linkage) (~1100 cm^{-1}) responsible for spherical shape of GO. Fluorescence spectra (Fig. 1: f)

in PBS buffer confirms the presence of quantum dot[14] like nature of this GO since with increasing excitation the wavelength , emission wavelength changes. Thus a method has been developed to synthesize small size spherical GO.

These GO smoothly cross not only through the BBB into the brain of CADASIL[12] mice but also through the GBM induced mice. The gradual enhancement in fluorescence (Fig. 2: a,b,c) in the vessels and also in the background clearly demonstrate the passage of GO in BBB.

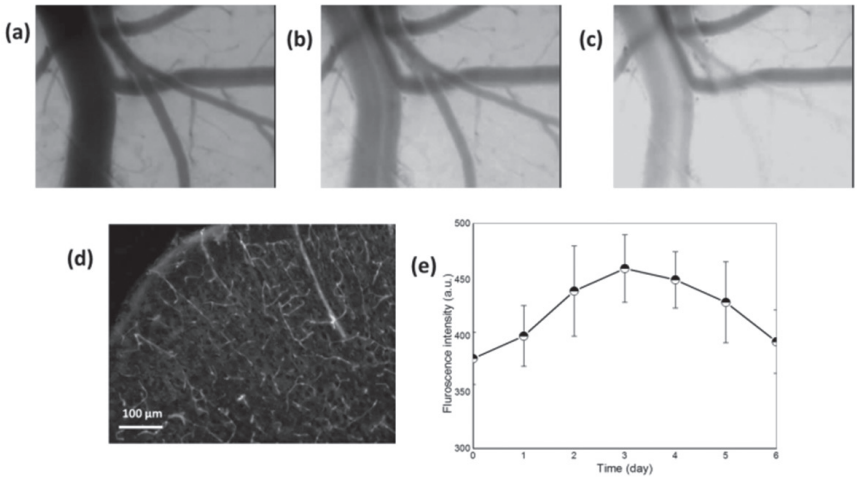


Fig. 2: Mice model study: In vivo image of brain of mouse :(a) First few sec, (b)16th sec and (c) After 40th sec are frozen shots showing the passage of fluorescent GO (d) Mouse sacrificed an hour after GO treatment, (labelling of floating section of brain cortex (100 µm) under fluorescent microscope with two colour channels (red, GO and green) auto-fluorescence lectin stained vessels of sacrificed mouse after an hour after GO treatment (e) Excreta study (excitation 488 nm, emission 613 nm).

Sacrificed mice brain slice imaged by fluorescence microscopy using two colour channels confirms the presence of GO(red) and lectin (green). Interestingly the GO injected mice when sacrificed after three days; the clearance of the red fluorescence (due to GO) is observed (not shown). The GO do not accumulate in the brain but readily goes out under normal condition since gradually the distribution of fluorescent GO (Figure 2: e) diminished in the exposed mice wherein the fluorescent GO is continuously released in their excreta. This property of GO is unique as these are PBS buffer soluble and do not

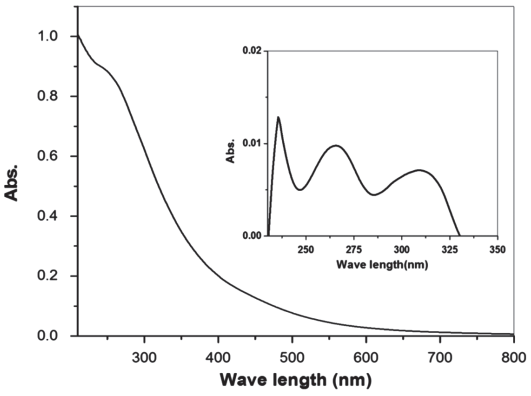


Fig. 3: Drug encapsulation study: GO-DZ composite in PBS buffer, pH-7.4 showing the open fist form of GO releasing DZ that has been extracted with DCM (inset: DCM extracts showing the electronic signature of DZ)

deposit inside for a long period in contrast to other dispersed but insoluble nano species.

Encapsulation of Donepezil drug confirmed in Fig. 3 as when pH of the buffer increased and drug molecule get solubilised in DCM which was not present when pH of the solution is lower.

The synthesized GO are providing promise for applications in areas such as bio imaging, drug delivery in brain since we have successfully entrapped drug molecule inside it.[15, 16]

Significance

In this work, an easy method is invented to isolate GO from low grade coal. When this new type of GO which can be opened and closed on external stimuli, injected through tail of both mice, we observed the passage of GO through BBB to the tumour and also to the neuronal sites. Interestingly the images of the brain of animals sacrificed after 3 days, showed no sign of GO, suggesting that the GO don't accumulate in the brain of the animals however get freed as body waste. Thus we are delighted to report that this new types of GO can cross through the BBB and enter the brain and it is excreted from the body in three days. This raises great prospect of using GO for drug delivery to the brain. We can also entrap any relevant drug molecule inside our cargo (GO), which will now act as Trojan horse and will cross the BBB carrying the drug inside the brain and deliver it on that specific end on external stimuli. The non-toxic GO will be excreted out of the system within three days.

Acknowledgement

The authors thank DST-SERB, GOI and Cromoz. Inc., USA. It is worth to mention the support of Dr. Mitrajit Ghosh, Afreen Allam, Prof. Dr. N. Plesnila and Dr. Ralf providing relevant mice used in these experiments. BP also acknowledges the support of lab mates and several summer research fellows in this work.

1. M. Bonijoly, M. Oberlin and A. Oberlin, Int. J. Coal Geol., **1**, 283-312, 1982.
2. Govt. of. India, Ministry of Coal, Coal Grades, http://www.coal.nic.in/content/coal-grades, Accessed 23/04/2015, 2015.
3. P. Boral, A. K. Varma and S. Maity, Curr Sci, **108**, 384-394, 2015.
4. C. F. K. Diessel, R. N. Brothers and P. M. Black, Contr. Mineral. and Petrol., **68**, 63-78, 1978.
5. W. S. Hummers and R. E. Offeman, J Am Chem Soc, **80**, 1339-1339, 1958.
6. R. Ye, C. Xiang, J. Lin, Z. Peng, K. Huang, Z. Yan, N. P. Cook, E. L. G. Samuel, C.-C. Hwang, G. Ruan, G. Ceriotti, A.-R. O. Raji, A. A. Martí and J. M. Tour, Nat Commun, **4**, 2013.
7. B. Obermeier, R. Daneman, R. M. Ransohoff, Nat Med, **19**, 1584-1596, 2013.

8. F. Fernández-Klett, N. Offenhauser, U. Dirnagl, J. Priller, U. Lindauer, Proc Natl Acad Sci, **107**, 22290-22295 , 2010.
9. A. Armulik et al., Nature, **468**, 557-561, 2010.
10. M. Saxena and S. Sarkar, RSC Advances, **4**, 30162-30167, 2014.
11. A. Joutel et al., Nature, **383**, 707-710, 1996.
12. E. A. Winkler, R. D. Bell, B. V. Zlokovic, Nat Neurosci, **14**, 1398-1405, 2011.
13. W. E. Heydorn, Expert Opin Investing Drugs, **6**, 1527-1535, 1997.
14. D. Pan, J. Zhang, Z. Li, M. Wu, Adv Mater, **22**, 734-738, 2010.
15. B. Pakhira, M. Ghosh, A. Allam and Sarkar. RSC Adv., **6**, 29779-29782, 2016.
16. B. Pakhira, S. Ghosh, S Maity, D. N Sangeetha., A. Laha, A. Allam and S. Sarkar, RSC. Adv., **5**, 89076-89082, 2015.

PROPERTIES, SCIENCE AND LARGE APPLICATION OF SMALL

Bhaskar Das [a*]

[a]*Dept. of Physics, Sister Nibedita Govt. General Degree College for Girls, Hastings House, Kolkata-700027*

Abstract

The research on nanomaterials has been one of the important areas of research in Physics, Chemistry, Biology and Engineering in the last twenty years. The properties of huge number of materials are size dependent *i.e*. at the nanoscale regime a material may display totally different properties. Changing the size, shape and/or surface configuration the electronic and optical and many other properties of semiconductor or metal nanoparticles can be manipulated. Mainly two factors have motivated the researchers to grow their interests in the research on nanomaterials; one is fundamental findings in the exceptional properties of the materials at the nanoscale and the other is the application of the nanomaterials. So far the most relevant physics at the nanoscale is 'quantum effects'. There are some other physical properties like surface properties which are equally important to understand the properties of materials at the nanoscale. The present paper reviews some selected properties, science and applications of nanomaterials.

Keywords: Nanoparticles; Quantum confinement; Surface properties; Defects.

I. Introduction

Material properties become size dependent when they are reduced to the nanoscale, *i.e*. properties which are independent of size in the bulk form may become dependent on size when one or more dimensions of a material is reduced to the nanoscale. Consequently, in the nanoscale regime a material may display totally different properties[1]. Along with size, shape and surface configuration of a nanomaterial also play significant role in the overall property of any nanosystem. Therefore, in principle, it is possible to tune different properties of materials by manipulating size, shape and/or surface configuration[2,3]. Research interests on nanomaterials have so far been directed to understand the fundamental science behind exceptional properties of the materials at the nanoscale as well as to use the size dependent exotic properties for various applications. Of the different types of nanostructures, semiconductor, carbon and metallic systems have been very extensively studied. Low-dimensional semiconductor nanostructures usually exhibit size dependent band gap that give rise to

* Corresponding author: Mob No.: 9434444005; E-mail address: dbhaskarmtb@gmail.com

ISBN : 978-81-933395-0-3

tunable and efficient optical emission and absorption. In most cases such characteristics are explained in terms of quantum confinement of excitons, although surface effects are also known to play a significant role. On the other hand, the most distinctive feature of noble metal nanoparticles is controllable absorption and scattering resonances resulting from surface plasmon (SP) excitations.

II. Some Size Dependent Properties at the Nanoscale

Mechanical Properties

Materials at the nanoscale show attractive mechanical properties and exceptional deformation behaviour. The elastic modulus of silver, lead nanowires and polypyrrole nanotubes is significantly higher for the smaller diameters than that of the larger ones at the nanorange and this is attributed to surface tension effects[4].

Electrical Properties

Conductance and resistivity measurements of nanomaterials demonstrate that the electrical properties depend significantly on the nanomaterial size and content. The dielectric permittivity and resistivity of the composite (metal-containing nanoparticles embedded in a polyethylene matrix) depend on the nanoparticle size and concentration[5]. It is observed that the conductance is quantized and that led to transport of superhigh current density at room temperature without heat dissipation in defect free carbon nanotube [6].

Optical Properties

With decreasing in size the optical properties shift to shorter wavelength (blue shift) in direct band gap semiconductor nanoparticles (NPs) like CdSe. This is explained by Quantum Confinement[7, 8]. The observations of absorption and emission shifts of porous Si and Si NPs show that the size dependent optical properties are present in indirect gap semiconductor as well [9] though the origin is not yet understood totally. Metal NPs can be distinguished from their bulk counterpart by optical properties. It is found that the colour of metal nanoparticle depends on the shape, size and the dielectric of the surrounding environment and this effect is very pronounced for the noble metal nanoparticles. The noble metal nanoparticles show their colours because of the surface plasmon resonance absorption [10, 11].

Thermal Properties

In a large no. of studies exceptional properties of thermal conductivity of the materials at the nanoscale have been observed. Optical phonon modes contribute a lot to heat flux in nanosystem [12]. Large surface to volume ratio and boundary inelastic scattering also play major role in thermal conductivity of nanomaterials.

Magnetic Properties

Magnetic nanomaterials show exceptional magnetic properties with respect to their bulk counterpart. The particles size between 1 nm to 100 nm may display supermagnetism[13]. The unusual behaviours of magnetic nanomaterials are mainly due to surface or interface effects, breaking of symmetry and charge transfer.

III. Quantum Size Effects at the Nanoscale

Quantum Confinement

When the size of a nanoparticle is smaller than the de Broglie wavelength, electrons or excitons are spatially confined and discrete energy levels are formed.This quantum size effect is most pronounced for semiconductor nanoparticles, where the band gap increases with decreasing size and the valence and conduction bands break into discrete levels similar to a particle in a box (Fig. 1). Both absorption and emission spectra shift to higher frequencies with decrease in nanocrystal (NC) size. This phenomenon has been experimentally verified for several NC systems. For example, by Bawendi reported that the band gap emission of spherical CdSe nanoparticles shift from red to blue emission with decrease in particle size (Fig. 2). At the nanoscale, electrons are confined and exhibit wave behaviour. Hence they are best represented by wave functions. Schrodinger equation comes into play to find the allowed electronic energy levels. According to free electron model, the energy of the electronic states varies as $1/L^2$, where L is the dimension of the system. As the size of the system decreases the allowed energy bands

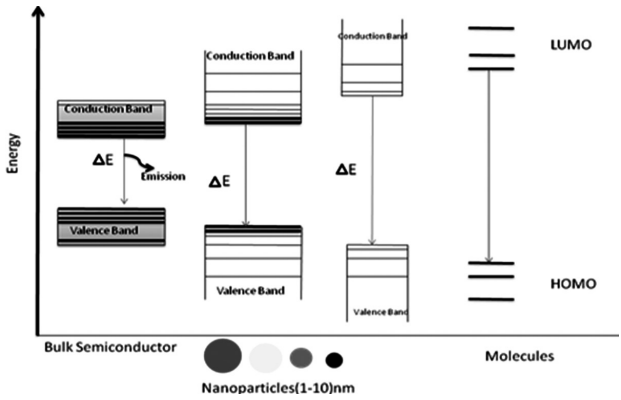


Fig. 1: Schematic of semiconductor energy levels at different material sizes.

Fig. 2 : Fluorescence induced by exposure to ultraviolet light in vials containing various sized Cadmium selenide (CdSe) quantum dots (www.nn-labs.com)

become substantially narrower in comparison with infinite solid. The electrons in a decreased dimensional system behave like 'particle in a box' which is the phenomenon of quantum confinement.

Tunnelling

Tunnelling is a fundamental quantum effect. At the nanoscale as the electrons are confined and exhibit wave behaviour, they can penetrate into an energy region

which is classically not possible. Scanning tunnelling spectroscopy is used to investigate NCs.

IV. Surface Properties

Physical and chemical properties of matter depend a lot on surface properties. Properties like catalytic reactivity, electrical resistivity, and chemical reactivity depend on the nature of interface. At the nanoscale collective surface area is

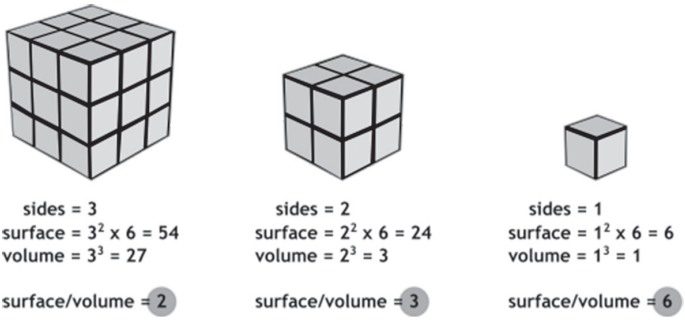


Fig. 3 : Surface to volume ratio increases.

increased (Fig. 3) and large numbers of atoms reside on the surface. Defects at the surface also play an important role to determine properties like photoluminescence (PL), absorption, electronic transport etc. at the nanoscale.

V. Localised Surface Plasmon Resonance of Metallic NPs

When light (electromagnetic field) interacts with metal surface a group of valence electrons move in a direction parallel to the metal/dielectric interface giving rise to surface plasmon.In NPs the surface plasmon is localised in space and hence oscillates in synchronised way in a small space. The resonance condition established when the frequency of this oscillation matches with the frequency of the incident light. This is called localised surface plasmon resonance (LSPR). Metal NPs have very strong visible absorption due to LSPR effect (Fig. 4).

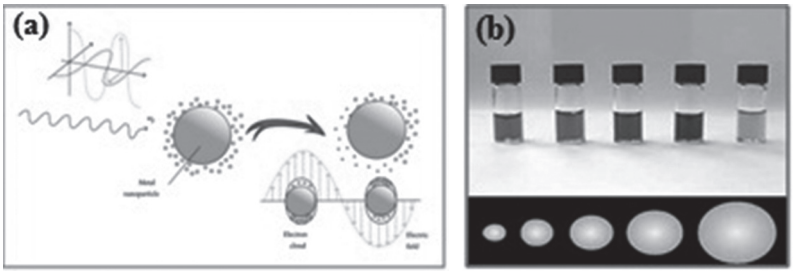


Fig. 4 : (a) Schematic of LSPR in a metallic nanoparticle; (b) Colloidal nanoparticles of gold.

VI. Selected Applications of Nanomaterials

There are thousands of areas where nanomaterials and nanotechnologies are being used. Some key areas where nanomaterials are being applied in recent years are: Solar

Cells, LED, LASER, Displays, Medicine, Water Purification, Sensors, Catalyst, Bio-imaging, Construction, Sunscreen, Paints.

VII. Conclusions

Research on nanomaterials is still young. Thousands of papers are being published on nanomaterials and nanoscience every year all around the world. Nanomaterials display exceptional properties with respect to their bulk counterpart. There is an endless list of application of nanomaterials however a no. of fundamental questions are still there to be answered.

References:

1. Luisa Filipponi and Duncan Sutherland *iNANO*, (2010)
2. A.L.Rogach, A.E.Ychmuller, S. G. Hickey, and S.V. Keshaw, *Small* 3(4), 536-557(2007)
3. J.Hollingsworth, And V. Klimov, Semiconductor and Metal Nanocrystal: Synthesis and Electronic and Optical properties, chapter 'soft' chemical synthesis and Manipulation of Semiconductor Nanocrystals, 1-64 New York: Marcel Dekker, Inc. (2004)
4. Cuenot, Stéphane, et al. "Surface tension effect on the mechanical properties of nanomaterials measured by atomic force microscopy." *Physical Review* B 69.16 (2004): 165410
5. Yurkov, G. Yu, et al. "Electrical and magnetic properties of nanomaterials containing iron or cobalt nanoparticles." *Inorganic Materials* 43.8 (2007): 834-844
6. S. Frank, P. Poncharal, Z.L. Wang, W.A. de Heer, Science 280 (1998) 1744
7. M. A. Reed, J. N. Randall, R. J. Aggarwal, R. J. Matyi, T. M. Moore, A. E. Wetsel, *Phys. Rev. Lett.* 60, 535-537(1988)
8. L. E. Brus, *J. Chem. Phys. 80*, 4403-4409(1984)
9. Y. Kanemitsu, *Phys. Rep., 263*, 1. (1995)
10. Eustis, S.; Hsu, H.-Y.; El-Sayed, M. A., Gold Nanoparticle Formation from Photochemical Reduction of Au3+ by Continuous Excitation in Colloidal Solutions. A Proposed Molecular Mechanism *J. Phys. Chem. B* 109, (11), 4811-4815(2005)
11. Rich, R. L.; Taube, H., The Induced Exchange of Cl- and AuCl4-. Evidence for Au(II). *J. Phys. Chem*., 58, (1), 6-11(1954)
12. J. Shiomi and S. Maruyama, Phys. Rev. B: Condens. Matter Mater. Phys., 2006, 73, 205420.
13. A.-H. Lu; E. L. Salabas; F. Schüth (2007). "Magnetic Nanoparticles: Synthesis, Protection, Functionalization, and Application". Angew. Chem. Int. Ed. 46 (8): 1222–1244.

150th
Birth Anniversary
Celebration

STUDY OF UNNATURAL DNA BASE-PAIRS BY QUANTUM MECHANICAL AND CLASSICAL MOLECULAR DYNAMICS SIMULATION

Sk Jahiruddin [a*]

[a]*Department of Physics, Sister Nibedita Government General Degree College for Girls, 20B Judges Court road, Hastings House, Kolkata – 700027, West Bengal, India.*

Abstract

In May 2014 first semi-synthetic organism with artificial DNA bases has been reported in nature. We have chosen the unnatural base d5SICS and dNaM as their PCR replication capability and bio-compatibility is similar to the natural bases like Adenine, Guanine, Thymine and Cytosine. We have done quantum mechanical calculations to show that unlike these natural bases hydrogen bonds are absent in d5SICS and dNaM and the van der walls interactions is the key factor for stabilization of these pairs. Going one step further we simulated one small DNA segment including one set of d5SICS and dNaM and have shown that the pairs become planner mimicking the natural bases inside the DNA. The planarity has been ensured by the strong van der walls interactions between unnatural and their neighbouring natural bases, strongly stabilized by hydrogen bonds. The findings are very important as this indicates that the planarity and resemblances to natural bases may be the key to design a new unnatural base pair.

Keywords: Unnatural base pairs; UBPs; d5SICS-dNaM

I. Introduction

Physics at bio and bio-nano interface is still in infancy and is in urgent need to be developed. For example if we want to design a novel drug for a deadly disease, we must know where and how the drug will interact. And without knowing the mechanism of interaction between the drug molecule and site of action (protein, DNA etc) we can't predict the efficiency. Here comes the physics of bio-systems.

Another very important subject of study is application of modified bio-molecules. There has been tremendous effort throughout the world to design new base-pairs of DNA which are different than the natural ones (Adenine, Guanine, Thymine and Cytosine). These artificially designed bases are called unnatural bases. The unnatural bases, if successfully exist and replicate inside natural organisms, can bring a total revolution in genetic engineering as they have potential to synthesis new proteins and thus totally alternate the existing body functioning. For example we have the possibility that our body will synthesize a new protein by a code which includes an unnatural base

* Corresponding author: Phone: +918116523464; E-mail address: jahir.physics@gmail.com

ISBN : 978-81-933395-0-3

and the new protein will strengthen our body immunity system to fight against cancer. Theoretical understanding of the mechanism of interaction of unnatural bases both unnatural-unnatural and unnatural-natural is the key of success to design the unnatural bases and thus expanding the genetic code.

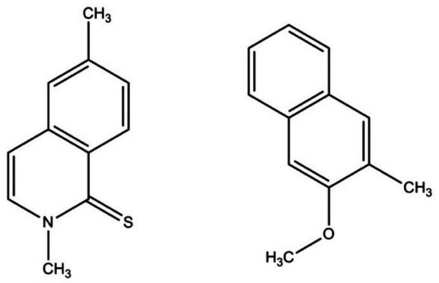
2. Computational Methods

We have used density functional theory (DFT) calculation for electronic structure and molecular dynamics to reveal the structure of the molecules in the real environment. DFT calculations give energy at zero temperature whereas the MD calculations give structure and dynamics at any reasonable temperature. We have used the sequence 5′-TCACAXTTCCA-3′ which contained 11 bases to run the dynamics for 100ns in aquatic environment. We have chosen the temperature of 310 kelvin to mimic the real environment of the body.

3. Results

DNA is the key to life. The sequence and specificity of the nucleic acid base-pairs in DNAs determine the synthesis, structure and functions of proteins. There are four natural base pairs – Adenine, Thymine, Guanine, and Cytosine. Any other molecules, combination or defects in the natural bases amounts to a mis-pair which mostly rejected and repaired by body enzymes. Some defects like methylation of Cytosine escapes the rejection mechanism of body enzymes and leads to mutations. There has been a focussed research towards synthesis of unnatural base-pairs which can possibly be incorporated into natural DNA and replicated inside DNA PCR and possibility inside living cells of some organism. If possible, this research has immense important implications for designing new synthetic biomaterials, DNA base sensors, machines, drug delivery systems as well as expanding the existing genetic alphabet.

Recently a hydrophobic unnatural base pair (UBP), named d5SICS-dNaM which replicated in DNA PCR and also sustained and synthesized a plasmid inside E-coli genome have been reported by Romesberg and coworkers. Inspired by this work we have started calculating the bind energy of these molecules. UBPs prefer to stack one after another in free environment deviating from their supposedly possible orientation inside the DNA. In the stacked case they have large binding energy in the range of 10-12 kcal/mole. With this stacked orientation it will not be possible for the molecules to remain intact inside the DNA. However the real environment is different as it will be fused into DNA back-bone and natural DNA bases above and below. So we tried molecular dynamics of the molecule inside a DNA sequence of 10 natural and one unnatural base surrounded by water molecules. The MD results shows that, within a natural DNA tract, due to the combined effect of the



2,6-Dimethyl-2H-isoquinoline-1-thione (SICS) 2-Methoxy-3-methylnaphthalene (NaM)

Fig. 1 : Structure of UBPs: d5SICS and dNaM.

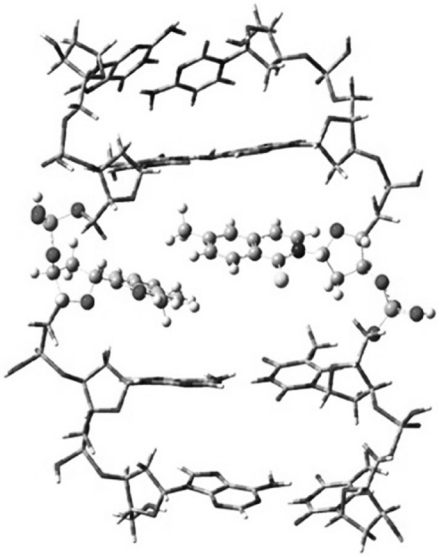


Fig. 2: Schematic Diagram of UBP inside DNA. Middile one is the Unnatural Base.

backbone and neighboring stacked bases, the UBPs become reoriented into planner structure, thus resembling the natural DNA bases.

Our Molecular Dynamics calculation run for 100 ns which is reasonably large time scale compared to the number of molecules present in the calculation. The molecules remained planer (See Fig-3) through the calculation. The data shows that the computed structure have an average end-end distance, $d_{C1'\text{-}C1'}$ = 10.8Å for d5SICS-dNaM. The result is in excellent agreement with available crystal structure (PDB ID: 3SV3, planar UBP with $d_{C1'\text{-}C1'}^{\ crystal}$ = 11.0 Å). The quantum mechanical model for the UBP surrounded by two natural base-pairs (A-T) on top and bottom on equilibrated MD structure found large binding energy of ΔE = –74.0 kcal/mol. This quantitatively establishes the fact that the UBPs can, indeed, be stabilized by dispersion interactions when there are no hydrogen bonds presents among them.

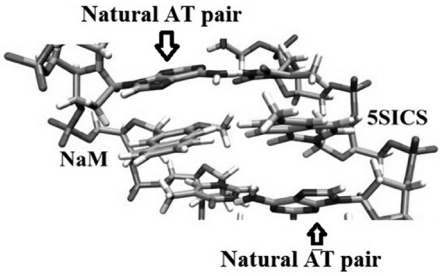


Fig. 3: UBP inside DNA at MD simulation.

Conclusions:

We have shown that the 5SICS-NaM pair which replicates in DNA PCR and can be incorporated in a living organism is stabilized in a slipped parallel configuration in the gas-phase quantum mechanical calculation. However, the molecules become planar like the natural base-pairs in classical molecular dynamics simulation, although in the absence of any hydrogen bonds. We have shown that dispersion interactions between the UBP and the natural base-pairs within the DNA loop (intrastrand) are very much important in the stabilization of the DNA bases. It is well known that the hydrogen bonding interactions between the natural bases stabilize the DNA as interstrand H-bonding is a stronger stabilizing force than intrastrand stacking interactions, but here that stacking interactions play a decisive role in stabilizing an UBP functionalized DNA. This explains how a molecule devoid of hydrogen bond can be stable inside natural DNA by the combined effects of backbone and the neighboring stacked bases. This is paradigm shift in the accepted metaphor of DNA interaction theory and thus can open a new area of computational screening of the potential DNA bases before this actually be tested in real laboratory.

Acknowledgement

Sk Jahiruddin thanks Professor Ayan Datta, Associate professor and Head, Dept. of Spectroscopy, IACS, Jadavpur, for supervision of the work.

References :

1. Malyshev, Denis A., Kirandeep Dhami, Thomas Lavergne, Tingjian Chen, Nan Dai, Jeremy M. Foster, Ivan R. Corrêa, and Floyd E. Romesberg. "A semi-synthetic organism with an expanded genetic alphabet." *Nature* 509, no. 7500 (2014): 385-388.
2. Jissy, A. K., and Ayan Datta. "Design and applications of noncanonical DNA base pairs." *The journal of physical chemistry letters* 5, no. 1 (2013): 154-166.
3. Riley, Kevin E., and Pavel Hobza. "On the importance and origin of aromatic interactions in chemistry and biodisciplines." *Accounts of chemical research* 46, no. 4 (2012): 927-936.
4. Hobza, Pavel, Heinrich L. Selzle, and Edward W. Schlag. "Potential energy surface for the benzene dimer. Results of ab initio CCSD (T) calculations show two nearly isoenergetic structures: T-shaped and parallel-displaced." *The Journal of Physical Chemistry* 100, no. 48 (1996): 18790-18794.
5. Jissy, A. K., Sukanya Konar, and Ayan Datta. "Molecular switching behavior in isosteric DNA base pairs." *ChemPhysChem* 14, no. 6 (2013): 1219-1226.
6. Grimme, Stefan. "Density functional theory with London dispersion corrections." *Wiley Interdisciplinary Reviews: Computational Molecular Science* 1, no. 2 (2011): 211-228.
7. Riley, Kevin E., and Pavel Hobza. "Noncovalent interactions in biochemistry." *Wiley Interdisciplinary Reviews: Computational Molecular Science 1*, no. 1 (2011): 3-17.

150th
Birth Anniversary
Celebration

EFFECT OF PERCENTAGE OF BODY FAT (PBF) ON THE REPRODUCTIVE HEALTH OF ADOLESCENT GIRLS

Piyanka Sengupta [a*], Krishna Roya [b] and Bulbul Thakura [c]

[a]*Assistant professor, Sister Nibedita Govt. General Degree College for Girls;*

[b]*Professor and Principal, Sister Nibedita Govt. General Degree College for Girls;*

[c]*Associate Professor and Head of the Department of Physiology, Raja Peary Mohan College*

Abstract

It is well proven that a healthy woman can create a healthy nation. Among the various facets of women's health, reproductive health has got special importance. There are various factors which regulate the course of menstrual health in girls. This study was done to find out the roles of such important but less studied fact like Percentage of Body on the onset of menarche, frequency of menstruation and other related factors of menstrual health. 75 school going girls (age 16 to 18) were selected for anthropometric measurements with standardized protocols and PBF was measured using BIA technique. Their menstrual profiles were diagnosed with standardized questionnaire. The result indicated that the samples were mainly underweight and had PBF < 17 and their age of menarche frequency of menstruation was not of the normal standard. The girls who were found to be obese had PBF > 35 and they complained about dysmenorrhea, and symptoms of PCOS. The results were statistically significant (p 0.05). Thus the study emphasized on the tentative role of proper percentage of body fat to be essential for maintaining a healthy reproductive profile of women throughout the life cycle.

Keywords: PBF; Adolescent girls; Menstrual health.

1. Introduction

Women's health is influenced by multiple factors. Among various facets of women health, reproductive health holds special importance. Menstrual profile of women is a part of reproductive life which from the very beginning forms the base of her fertility levels in future[1]. There are various factors which govern situations like age of menarche, the course of menstrual flow, its frequency and other associative situations. Their lifestyle pattern, diet, body weight are few such factors and in them the percentage of body fat is an important condition regulating menstrual as well as reproductive outcomes in women.

It is well known that change in body weight has a direct effect on reproductive health in both male and female population[2]. Previously BMI (body mass index) was

* Corresponding author: Phone: 9883921075, E-mail: piyankasg@gmail.com

ISBN : 978-81-933395-0-3

widely used in predicting obesity or body fat[3] but it could not distinguish between the difference of body fat and body weight [4].

That is why it is beneficial to use methods like estimation of body fat by BIA method to properly understand percentage of fat one has.

The Percentage of Body Fat (PBF) is considered to be the total mass of fat divided by total body mass; body fat includes essential body fat and storage body fat. Essential body fat is necessary to maintain life and reproductive functions. The percentage of essential body fat for women is greater than that for men, due to the demands of childbearing and other hormonal functions. The percentage of essential fat 10–13% in women (referenced through NASM)[5]. According to American Council of Exercise, the PBF for women to be considered as normal or healthy or physically fit should be between 21-24%.

Various studies have indicated that maintenance of a proper body fat within the normal range can avoid menstrual irregularities. Too less body fat or too high body fat percentage can cause abnormal menstrual cycle or in fact future reproductive health issues.

To understand such relation whether PBF can affect menstrual health or not, this current study was undertaken to evaluate the role of percentage of body fat on the onset and regular occurrence of menstrual cycle.

2. Materials

School girls aged 16-18 years were approached for this simple pilot study. Sample size was 75 and duration of the study period was 1 week. The aim of the study was to collect anthropometric details like height, body weight, and percentage of body fat (PBF). Menstrual profile of the subject was assessed by self-structured pre-tested questionnaire. The instruments which were used for the study were weighing scale, anthropometric rod, OMRON karada scan body fat analyser and self-structured questionnaire on menstrual profile of the young girls.

3. Methods

Body weight were measured with weighing scale, height was measured with anthropometric rod, body fat percentage was assessed with the help of Body Fat Analyser which is based on the principle of Bioelectrical Impedance Analysis (BIA)[6]. The measurements were taken for three times and then the average values were taken as the final one. Finally they were asked to fill up a questionnaire regarding their onset of menarche, their average duration of menstrual flow, and any associative symptoms of menstrual irregularities or polycystic ovarian syndrome in broad term.

4. Results & Discussion

Among 75 school going girls 45.7% students had low body fat percentage and about 25.3% possessed higher body fat percentage. It is clearly shown in the following table :

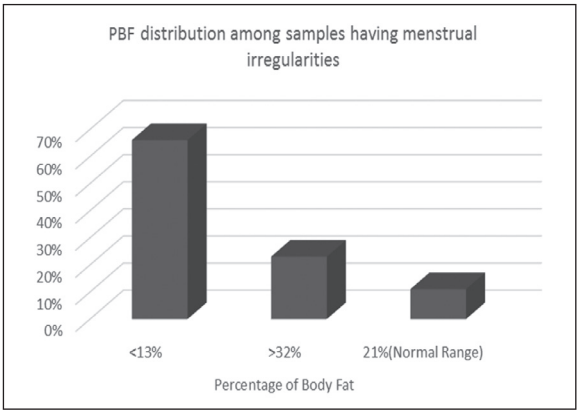
Table 1: Distribution of body fat among the samples (sample size 75)

Percentage of the Samples	Range of Percentage of Body Fat	Levels of PBF
45.7% of the sample	Less than 20%	Under fitness level
25.3% of the sample	Greater than 32%	Above fitness level
29% of the sample	Between 21-24%	Within the fitness level

On the contrary about 33 % of students had expressed about menstrual irregularities. Among them some were found to be overweight and obese though majority being underweight, with small population having normal body weight. This is demonstrated in the following table:

Table 2: Distribution of PBF (Percentage of Body Fat) among subjects having menstrual irregularities

Parameter studied	Total number of subjects in the survey	Number of subjects having menstrual irregularities	PBF among samples having menstrual irregularities	Range of value	Mean value
Percentage of body fat (PBF)	75	25	66% students who had PBF less than 17% (under fat)	11-17%	13
			23% had PBF greater than 32% (obesity level)	29-35%	32
			11% had PBF 17%-24% (normal level)	17%-28%	23



Student t test was performed with the help of IBM SPSS (version 2016) and the results were found to be significant at p value less than 0.05 and p value less than 0.01 respectively.

The left sided diagram clearly shows the variation of percentage of body fat (PBF) in samples having menstrual irregularities and other associative symptoms of polycystic ovarian syndrome (PCOS).

5. Conclusions

The above mentioned data strongly indicated that percentage of body fat, influence various situations of female menstrual cycle as well as reproductive profile which is of extreme importance in a woman's life. Essential body fat is required for synthesis of various reproductive hormones and also in maintenance of ovulation and menstruation.

Low body fat may cause problem in the conversion of Androgen to female sex hormones like Oestrogen.[7] On the other hand too much body fat reduces the rate of Oestrogen binding to SHBG (Sex Hormone Binding Globulin)[8] and thus produce problem in menstruation and if not treated, it may lead to future problems like amenorrhea, polycystic ovarian syndrome and even infertility.

Extreme body fat (both too less or too much) has a tentative role in creating severe problem in women's life in various aspect and this study was mainly done to promote awareness regarding maintenance of a proper normal body fat to prevent issues of reproductive health abnormality.

Acknowledgement

This study was done with all the help from the teachers and participating students of Uttar Para Govt. Girls High School for allowing us to perform this survey in their esteemed school.

References:

1. G.W. Mitchell and J. Rogers, The influence of weight reduction on amenorrhea in obese women. New England Journal of Medicine 1953; 249: 835–837, 1953
2. A. Agarwal and D. Durairajanayagam, Lifestyle Factors and Reproductive Health. Handbook of fertility; 13: 145-157, 2015
3. G. Dympna, B.H. Steven, H. Moonseong, Healthy percentage body fat ranges: an approach for developing guidelines based on body mass index1–3. American Journal of Clinical Nutrition;72: 694-701, 2000
4. T. J. Cole, Weight-stature indices to measure underweight, overweight, and obesity. In: JH Himes, ed. Anthropometric assessment of nutritional status. New York: Wiley Liss 83–111, 1991
5. ACE (2009) What are the guidelines for percentage of body fat loss? American Council on Exercise (ACE). Ask the Expert Blog. December 2, 2009.
6. A. C. Buchholz, C. Bartok, D. A. Schoeller, "The validity of bioelectrical impedance models in clinical populations". Nutr Clin Pract. 19 (5): 433–46, October 2004
7. K. Anderson, V. Nisenblat, R. Norma, Lifestyle factors in people seeking infertility treatment – a review. Aust N Z J Obstet Gynecol; 50 (1) : 8–20, 2010
8. S. Kirchengast, J. Huber, Body composition characteristics and fat distribution patterns in young infertile women. Fertil Steril; 81 (3) : 539–44, 2004

150th
Birth Anniversary
Celebration

A COMPARATIVE MOLECULAR PERCEPTION OF PHOSPHOENOLPYRUVATE CARBOXYLASE FROM RICE AND COMMON ICE PLANT

Samrat Bhattacharyya[a], Upala Saha[a], Paramita Nandy Datta[a*]

[a]*Department of Botany, Sister Nibedita Government General Degree College for Girls, Kolkata- 700027.*

Abstract

Mesembryanthemum crystallinum is a salt tolerant facultative halophyte with an ability to switch over into CAM mode of photosynthetic carbon assimilation under salt stress. This stress-induced transition is accompanied by a transcriptional increase in the activity of phosphoenolpyruvate carboxylase synthesizing gene Ppc1. On the contrary salt-sensitive plants like food crop *Oryza sativa var. indica* cannot undergo this metabolic alternation like salt tolerant plants. The amino acid alignment data shows 97% relatedness between rice and common ice plant Ppc1 gene, having similar coding regions in both the mRNA. Transcriptomic analytical study should prospectively investigate how differently PEPC gene transcriptional regulation works in rice. However, the similarity between Ppc1 genes in rice and ice plant is an intriguing observation of the present work that questions the tendency of rice PEPCase to be induced under salinity, despite the crop being salt sensitive.

Keywords: PEP carboxylase; Ppc 1; Common ice plant; Rice; Salt tolerance; Multiple alignment; BLAST.

Introduction

Phospho-enol-pyruvate carboxylase (PEPC; EC 4.1.1.31) is an enzyme that catalyzes irreversible β-carboxylation of phosphoenolpyruvate (PEP) in the presence of HCO_3^- and Mg^{2+} to yield oxaloacetate (OAA) and inorganic phosphate (Pi). In the leaves of C3 plants, the primary function of PEPC (Fig. 1) is to replenish the tricarboxylic acid (TCA) cycle with intermediates that are withdrawn for a variety of biosynthetic pathways and nitrogen assimilation. In CAM (Crassulacean Acid Metabolism) plants, the reaction catalyzed by PEPCase is the primary fixation step of photosynthetic CO_2 assimilation into oxaloacetate. The C4 enzyme PEP carboxylase is physiologically advantageous to plants living in equatorial or tropic, extremely hot and all year long brightly illuminated climates. The most effective attributes of PEP carboxylase over the main carbon assimilating C3 enzyme RuBP carboxylase include; ability to bind CO_2 at lower concentration, absence of O_2 binding activity eliminating chances of

* Corresponding author: Email – paramita_nandy@yahoo.com

ISBN : 978-81-933395-0-3

energy loss due to photorespiration, carbon fixation in cytoplasm and combination of energy efficiency with water conservation (Ripley et al., 2007, 2010; Taylor et al., 2010, 2014)[1]. Thus C_4 pathway is a relevant to plants adapted under stress.

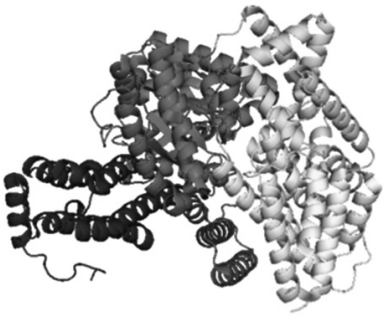


Fig. 1: Single subunit homology model of PEPC (generated by PyMOL)

The facultative halophyte *Mesembryanthemum crystallinum* or common ice plant (Fig. 2A) usually uses C3 carbon fixation, but when it becomes water- or salt-stressed, it switches to Crassulacean Acid Metabolism (Winter et. al, 2006)[2]. Salt combating mechanism includes Na^+ ion extrusion in the apoplast and cytosolic Na^+ inclusion within vacuoles (Cosentino, 2010)[4] (Fig. 2B). This stress-induced metabolic transition is accompanied by up to 50-fold increase in the activity of phosphoenolpyruvate carboxylase. The PEPCase isogenes, Ppc1 and Ppc2 have conserved intron-exon organizations, are 76.4% identical at the nucleotide sequence level within exons, and encode predicted polypeptides with 83% amino acid identity (Cushman et al, 1989)[3].

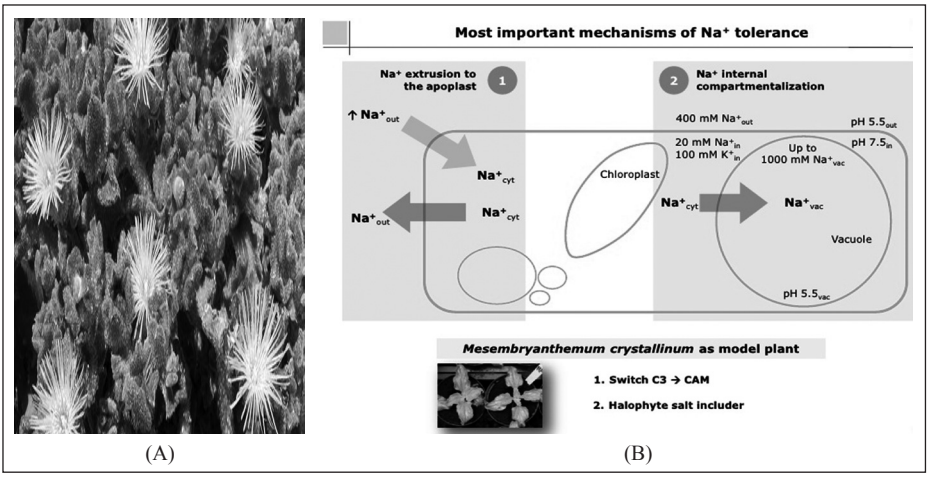


Fig. 2: (A) Common ice plant; ***Mesembryanthemum crystallinum***. (B) Salt compartmentalization mechanism in common ice plant (Cosentino. C, 2010).

While the expression of Ppc1 is clearly under transcriptional control, one cannot rule out the possibility that additional levels of gene regulation such as changes in mRNA turnover rates or alternate processing of large pre-mRNA molecules are involved in regulating the expression of Ppc1 (Cushman et al, 1989) [3]

On the other hand, salt sensitive plants which are incapable of switching over to C4 or CAM mode under salt stress must have different transcriptional signalling that operates in salt tolerant plants. The ability of plants to tolerate salt is determined by multiple biochemical pathways that facilitate retention and/or acquisition of water, protect chloroplast functions, and maintain ion homeostasis (Blumwald, 2000)[5]. Essential pathways include those that lead to synthesis of osmotically active metabolites,

specific proteins, and certain free radical scavenging enzymes that control ion and water flux and support scavenging of oxygen radicals or chaperones.

Rice (*Oryza sativa var. Indica*), the common food grain plant is a salt sensitive C3 herb. Its relatively salt tolerant varieties like IR65192-4B-10-13 are perceived as a high demand crop with prospective values (Prasad et. al, 2000)[7] (Fig. 3B). Salt tolerance mechanisms as observed in rice and its wild salt tolerant grass relatives are; restriction of salt uptake, sequestering salt into leaf sheath and compartmentalisation of toxic ions into vacuoles and cell wall (Fukuda et. al, 2004)[6] (Fig. 3A).

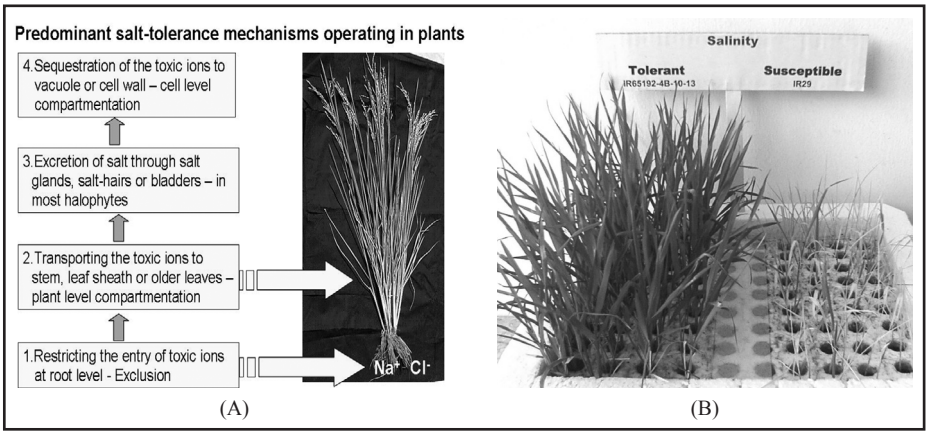


Fig. 3 : (A) Salt tolerance mechanisms in plants. (B) Variable salt susceptibility in rice varieties (Prasad et. al. 2000).

Under salt stress conditions, rice is unable to metabolically switch over to C4 or CAM photosynthesis and thus transcriptomic study should investigate how Ppc transcriptional regulation works in rice. This present work represents a comparative study of rice and common ice plant Ppc gene nucleotide sequence and amino acid sequence similarity that might project a molecular insight regarding the difference of transcription modes in both the plants.

Methods

All available reported complete gene sequences of PEP carboxylase coding gene Ppc1 from common ice plant and rice,were retrieved after screening from the databases of the National Centre for Biotechnology Information, USA (www.ncbi.nlm.nih.gov) and the European Bioinformatics Institute, Cambridgeshire, UK (www.ebi.ac.uk), updated March 2015. The subjected species were studied on the basis of the percentage of nucleotide sequence homology by BLAST® (Altschul et al., 1990) (Blastn,www.blast.ncbi.nlm.nih.gov/Blast.cgi). Amino acid and nucleotide sequences from the selected species were further analysed by a number of multiple sequence alignments (MULTALIN/Corpet, 1988) using an online server www.multalin.toulouse.inra.fr/multalin.

Results

The PEPCase gene from *Mesembryanthemum crystallinum* (facultative CAM plant) spans a region of 8050 bp and is interrupted by 9 intron stretches, whereas that from *Oryza sativa var indica* (C3 plant) extends for 2981 bp, but contains 9 intron sequences

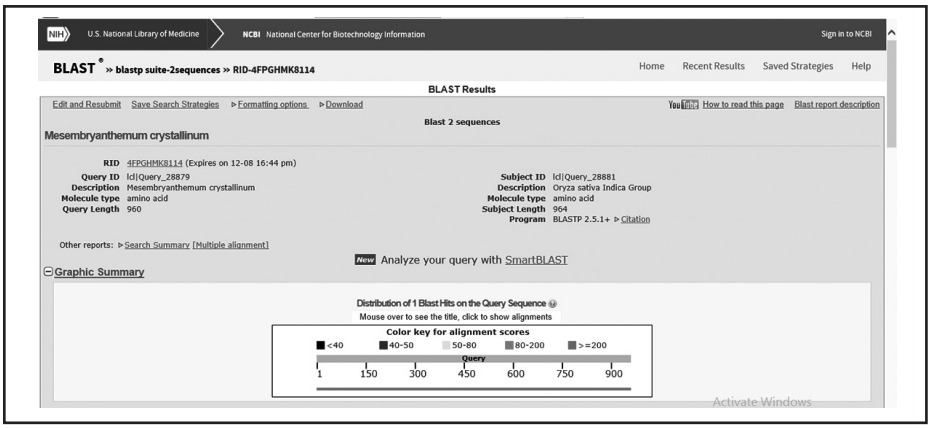


Fig. 4: Amino acid sequence BLAST hit

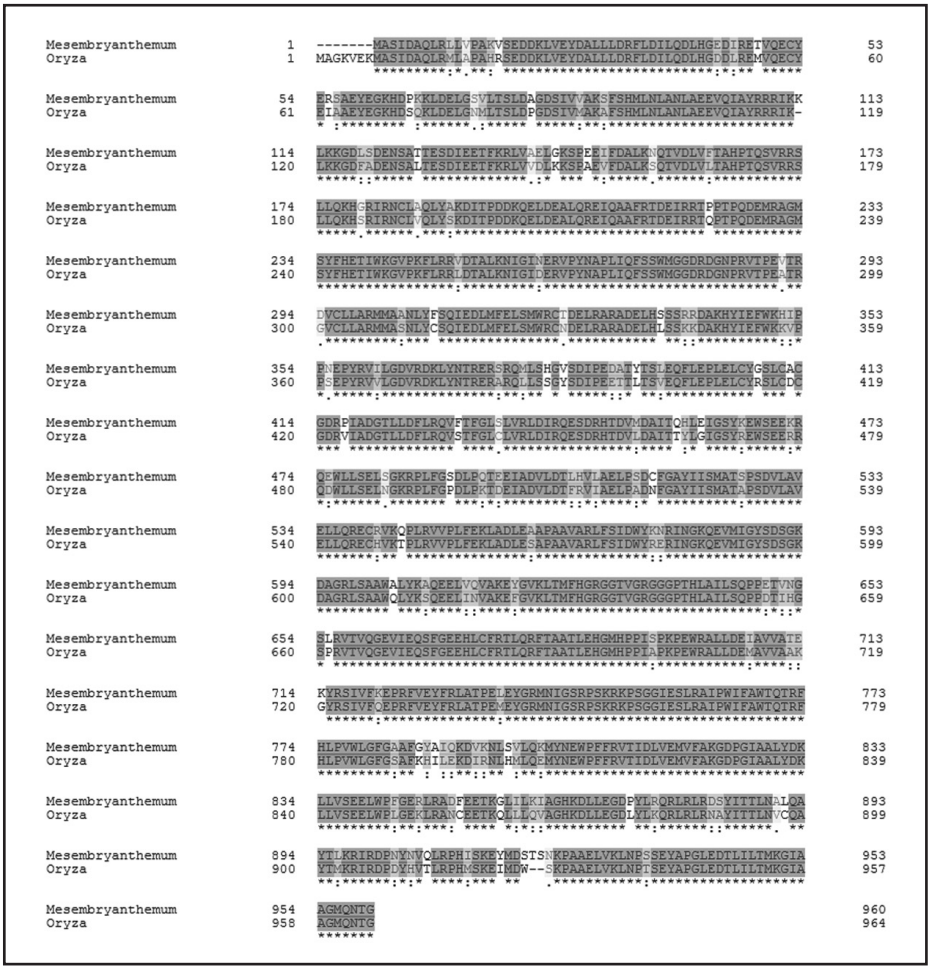


Fig. 5: Amino acid alignment with sequence similarity

as well. However, the amino acid alignment shows 97% relatedness, showing similar coding regions in both the mRNA (960 codons for *Mesembryanthemum* and 964 codons for *Oryza sativa*) (Fig. 4). Most of the difference in gene size is, therefore attributed to differences in intron sizes. The *Mesembryanthemum* amino acid sequence is 4 amino acids shorter than that of *Oryza sativa var. indica*. The sequences are essentially collinear, except for a 7-amino acid deletion close to the amino-terminus in the *Mesembryanthemum* gene product and a 2-amino acid deletion corresponding to the positions 927 and 928 in the *Oryza* peptide sequence (Fig. 5). The computational data almost entirely simulates with the earlier experimental result comparing the two isoforms of Phosphoenolpyruvate Carboxylase Ppc1 and Ppc2 from *Mesembryanthemum crystallinum* that switches from C3 to CAM type under continued salt stress. The rice gene corresponds to Ppc1 and that from the common ice plant is its Ppc2 type. The early experimental data clearly indicated that the transcript of Ppc1 increased over 30-fold after 5 days of salt stress (Cushman et al, 1989)[3].

Conclusion :

The similarity in the coding sequences obtained by the present computation on the two selected types of PEPCase (common ice plant and rice) also points to the transcriptional control on rice gene induction, if any, under stress. However, the similarity of *Oryza* PEPCase gene with Ppc1 is the most challenging observation of the present work that indicates the probability of rice PEPCase to be induced under salinity, despite the crop being salt sensitive. Moreover, the homology of rice gene with Ppc1 strongly supports the earlier experiments on PEPCase from the intermediate species with C3 protein that for the reversible transition from the C3 to CAM mode of photosynthesis, the C3 type of PEPCase is sufficient.

References :

1. Samuel H. Taylor, Brad S. Ripley, Martin Tarryn, F. Leigh-ann DeWet, Ian Woodward and P. Osborne. 2014. Physiological advantages of C4 grasses in the field: a comparative experiment demonstrating the importance of drought. *Global Change Biology* 2014 Jun; **20(6): 1992-2003.**Published online 2014 Mar 28. doi: 10.1111/gcb.12498
2. K.Winter and A.M. Holtum. 2006. Environment or Development? Life-Time Net CO_2 Exchange and Control of the Expression of Crassulacean Acid Metabolism in Mesembryanthemum crystallinum. *Plant Physiology*, January 2007 **143 (1): 98-107**.
3. J.C. Cushman, C.Meyer, C.B. Michalowski, and H.J Bohnert, 1989. Salt stress leads to differential expression of two isogenes of phosphoenolpyruvate carboxylase during Crassulacean acid metabolism induction in the common ice plant. *Plant Cell*, 1989 **1(7): 715–725**.
4. C. Cosentino , E. Fischer-Schliebs, A. Bertl , G. Thiel and U. Homann, 2010. Na^+/H^+ antiporters are differentially regulated in response to NaCl stress in leaves and roots of Mesembryanthemum crystallinum. *New Phytologist*. 2010 May; **186(3):669-80**.
5. E. Blumwald, G.S. Aharon, M.P. Apse. 2000. Sodium transport in plant cells. *Biochimica et Biophysica Acta.* **1465: 140-151**.
6. A. Fukuda, A. Nakamura, A. Tagiri, H. Tanaka, A. Miyao, H. Hirochika, and Y. Tanaka. 2004. Function, Intracellular Localization and the Importance in Salt Tolerance of a Vacuolar Na^+/H^+ antiporter from Rice. *The Plant Cell Physiology*. **45(2): 146-159**.
7. S.R.Prasad, P.G Bagli, , S.Hittalmani, and H.E.Shashidhar, 2000. Molecular mapping of quantitative trait loci associated with seedling tolerance of salt stress in rice (Oryza sativa L.). *Current Science,* **78 : 162-164.**

150th Birth Anniversary Celebration

DNA, AN ALTERNATIVE "ENERGY", REPLACING CONVENTIONAL COMPUTATION IN NEXT ERA

Dr. Rajarshi Roy [a*]

[a] *Department of Botany, Sister Nibedita Govt. General Degree College for Girls, Hastings House, Kolkata-700027*

Abstract

DNA (Deoxyribo Nucleic Acid) can solve an unremarkable computational problem with a remarkable technique, a landmark demonstration of computing on the molecular level solving how a hypothetical Salesman finds route through set of five cities of USA using DNA as energy fuel by a traditional computing method at molecular level. The data sensitive nature of DNA is impressive due to its nucleotides spacing at 0.35 nanometers *i.e,* equal to 18 Mbits per inch which is more than data density of a high performance hard drive which is 7 Gbits per square inch. The spiral double helical ladder, its repairing mechanism and controlling operational proteins makes it an *Error correction device*. DNA computers are non-von Neuman stochastic machines controlling computations in a new manner. DNA replicates in bacteria at a rate of 500 bp / second, can serve as a power for DNA computing with a data rate as fast as 2000 bits / sec. DNA solves "travelling Salesman problem", much faster than silicon. List of 20 cities route coverage theoretically takes 45 million Gbytes of memory and a 100 MIPS computer will take two years, DNA computation takes 10- 15 nano mole of material to complete this route parallely due to its fitting in small space, fast data string generate mechanism, and parallel selection of enzyme. In this experiment DNA represents a string of data representing each city by words of six bases acting as *primers e.g.* : Los Angeles - GCTACG, Chicago – CTAGTA, Dallas- TCGTAC, Miami - CTACGG, and New York - ATGCCG. The entire itinerary can be encoded by simply stringing together DNA sequences joining the above routes, LA → Chicago → Dallas → Miami → New York would simply be GCTACGCTAGTATCGTACCTACGGATGCCG connected by DNA ligase enzyme. DNA is sorted by length corresponding to 5 cities. This experiment somehow takes help of old algorithm but one day new algorithms will allow DNA to overtake conventional computation and set a new record.

Keywords: Nucleotides; von Neuman; Primers; Ligase.

Introduction

An unremarkable computational problem can be solved with a remarkable technique using DNA *i.e,* a landmark demonstration of computing at the molecular level. The

* Corresponding author : Email Id: rajarshiroy2011@gmail.com, Phone: 9433101146, 7980582541

ISBN : 978-81-933395-0-3

problem can be solved using "*directed Hamilton Path*" (HP) problem but it is popularly recognized as a variant of "*travelling salesman problem*" where a hypothetical salesman tries to find a route through a set of cities such that he visits each city only once. As the number of cities increases the problem becomes more difficult. In the present experiment five cities were taken so that it can be solved easily. DNA is used to solve this class of problem that is difficult to solve using traditional computing methods. It is an example of using computation at a molecular level demonstrating unique aspects of DNA as a data structure and DNA computation works in a parallel fashion. DNA has an impressive data density. DNA is made up of four bases A, T, G, C which are spaced at 0.35 nanometers along the DNA molecule giving it 18Mbits per inch data density which is much more than a computer. The double stranded structure of DNA also makes it a unique data structure. DNA also has an error correction mechanism due to activity of enzymes on it.

DNA vs Silicon

DNA with a unique data structure and ability to perform many parallel operations can solve many computational problems that are mostly non-von Neumann, that approach computation in a different way from ordinary computers. In DNA computing, the power comes from the memory capacity and parallel processing. DNA replicates in bacteria at a rate of 500 bp/sec., can serve as a power for DNA computing with a data rate as fast as 2000 bits/sec. because DNA can replicate in parallel fashion. Post replication and synthesis of new strands continuously increases the data rate by 1000 bits/sec. So after 10 iterations, the DNA being replicated at a rate of about 1 Mbit/sec. and after 30 iterations it increases to 1000 Gbits/sec. This is beyond the sustained data rates of the fastest hard drive.

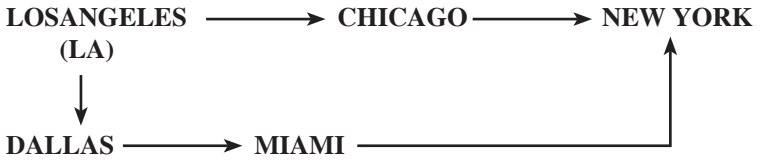
To solve the list of routes of a 20 city problem theoretically 45 million Gbytes of memory is required. For 100 MIPS computer, it would take two years to generate all paths. However using DNA computing, this method becomes feasible with nanomoles of DNA and routes can be searched not sequentially but parallely. DNA is the best choice to solve Hamilton Path problem as DNA is functional in small amount, it has many combinatorial techniques that can quickly generate many different data strings since enzymes work on many DNA molecules at once and the selection process is massively parallel.

DNA Computing and Primer Design

Hamilton Path problem is based on generation of all possible connecting routes. To select itineraries with the correct number of cities, select itineraries that contain each city only once. These thinking can be achieved by using standard molecular biology techniques. The strategy is to encode city names in short DNA sequences. DNA is treated as a string of data where each city can be represented by a word of six bases.

CITIES	*SEQUENCES*
LOS ANGELES	GCTACG
CHICAGO	CTAGTA
DALLAS	TCGTAC
MIAMI	CTACGG
NEW YORK	ATGCCG

The route is shown below:



The entire itinerary can be encoded by simply stringing together the DNA sequences that represents specific cities. For example the route from LA → Chicago → Dallas → Miami → New York would simply be GCTACGCTAGTATCGTACCTACGGATGCCG connected by DNA ligase. The molecule can be made by a machine called DNA synthesizer and linking them together in proper order. To get DNA strands representing itineraries with a random number of cities and random set of routes. One should be careful that selection of itineraries that start and end with the correct cities or DNA computation through Polymerase Chain Reaction (PCR) may give erroneous results. DNA is sorted by length and selection of DNA whose length corresponds to five cities is done. DNA encoded with itineraries that start and end with New York, the number of cities between Los Angeles and New York. This can be accomplished using gel electrophoresis, a common procedure that can resolve the size of DNA. Since we know that each city is encoded with six base pairs of DNA, we would isolate the DNA that was 30 base pairs long (five cities and each city six base pairs long).

Solve for Route

Successive filtration of DNA molecules by city was done with one city at a time. Since the DNA we start with contains five cities, we will be left with strands that encode each city once. Sequencing of DNA strands encoding five cities were done using graduated PCR technique using five primers corresponding to five cities. By measuring various lengths of DNA for each PCR product the final sequence of cities were known. For example, we know that DNA itinerary starts with Los Angeles and is 30 base pairs long, so if the PCR product for Los Angeles and Dallas primers was 24 base pairs long we can know that Dallas was the fourth city (24 divided by 6). With careful manipulation we can find out the correct sequence of cities with the sequences formed as product. For Los Angeles, Chicago, Miami, Dallas, and New York, with the succession of primers used is Los Angeles & Chicago, Los Angeles & Miami, Los Angeles & Dallas and Los Angeles & New York, we would get PCR products with lengths 12, 18, 24, and 30 base pairs. In this experiment what scales exponentially is not computing time, but rather the amount of DNA.

Conclusions

DNA can ever be utilized to solve "*travelling salesman problem*" with a more number of cities at a much faster rate than traditional computers is still a question. If number of cities increases more than 10,000, it certainly will not be solved with the procedure described above. New algorithms perhaps in one day allow DNA to overtake conventional computation and will set a new record. Today many companies

are manufacturing " DNA chips" where DNA strands are attached to silicon substrate (*e.g.* : Affymatrix gene chip). DNA manipulation is gaining speed, automation, and miniaturization. DNA is surely "the molecule of this century and the next century". One day will come when a laptop or tab will use DNA or DNA like bio-polymer as a computing device along with set of variously designed enzymes. DNA will be utilized to solve and study genetic programmes, algorithms, automata, language systems and many more complicated problems.

Acknowledgment

1. Prof. Leonard Adleman, University of Southern California. 3710. S. Mc Clintock Avenue, RTH 501, Los Angeles, C.A 90089-2905.
2. Will Ryu, Department of Physics, University of Toronto. 25, Harbord St. Toronto, O N M 5S : 3G5 Canada.

References

1. Leonard. M. Aldeman, American Computer Scientist. "Encyclopedia Britannica" Retrieved 2015-11-24.
2. G. Praun, "Computing with Bio-Molecules", Springer- Verlag, 1998.

TIME SERIES ANALYSIS & FORECASTING :MONTHLY DATA ON EXCHANGE RATE OF INDIAN CURRENCY (ERIC) PER US $ (JANUARY 1975 – DECEMBER 2008)

Ajoy Pal [a*]

[a]*Department of Statistics, Sister Nibedita Government General Degree College for Girls, Hastings House, Kolkata-700027*

Abstract

Most commonly, exchange rates are expressed as the number of units of domestic currency that will purchase one unit of foreign currency (*e.g*. units of currency per U.S. dollar). The International Financial Statistics (IFS) is a compilation of financial data collected from various sources, covering over 200 countries worldwide. IFS provides monthly exchange rates of currencies of its member countries. The monthly rates are the averages over daily rates. So in this paper an attempt has been taken to show how a univariate time series model for the data is built by analyzing the time series step by step and how the future value of exchange rate is forecast on the basis of the data. As an oil importing country, we experience high inflation rate, as a result of that we also experience deflation of our currency and hence forecasting of exchange rate of our currency is important.

Keywords: Time Series Model; Unit Root; Forecasting.

I. Introduction

International Financial Statistics(IFS) provides monthly exchange rates of currencies of its member countries against U.S. dollar. The monthly rates are the averages over daily rates. The data has been collected from the website of IMF.

Univariate time series models are a class of specifications where one attempts to model and to predict the variable under study by using only the information contained in their past values and possibly current and past values of the error term.

Here I have tried to review the method for building TS model to the data by using very well known advanced statistical tools which are used for finding different properties of a time series data in recent days.

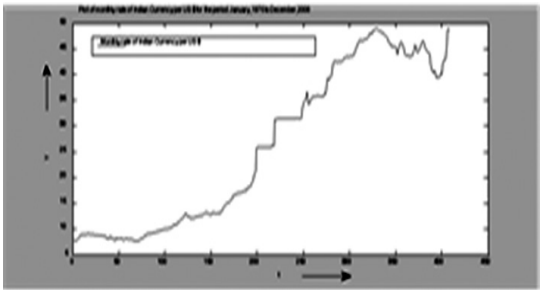
The structure of the article is as follows: In chapter 2 the attempt to build the appropriate time series model for the data has been developed, chapter 3 comprised of showing forecasting performances of the estimated model and looking for structural break within the data, conclusion has been drawn in chapter 4.

* Corresponding author : Mob No.: 9126798176; E-Mail Address : ajoypalstat@gmail.com

ISBN : 978-81-933395-0-3

II. Building TS Model

Here I have proposed a systematic approach to carry out the method of building a time series model. The steps to build the model are : Plotting the data and making visual inferences on it; Testing for stationarity; Testing for the seasonality in the data and removal of seasonality if it exists; Carrying out the Augmented Dickey Fuller (ADF) test to find the existence of unit root; Obtaining the most appropriate model (AR/MA/ARMA) for the whole stationary series obtained and then on an in-sample of size 80% and carrying out the diagnostic tests on residuals.



GRAPH :1

Plot of the Data

Comments: The above graph suggests that the series follows a smooth pattern and is rising slowly. The fluctuations around the series is minimal till the middle of the year 1991. Thus from the above graph we cannot comment about the presence of seasonality in the data and any strong evidence of structural break.

Testing for stationarity

The use of non-stationary data can lead to spurious regression. So test for stationarity is the next in analyzing TS data. For testing non-stationarity of stochastic type the ADF test is run. The null hypothesis of unit root cannot be rejected here as the p-value of the ADF test statistic is greater than 0.05 at 5% level of significance, *i.e*. there exists unit root. Thus at the level value the series is non-stationary. The lag length 1 has been decided based on Schwartz Bayesian Criteria. Also, the coefficient of Trend is significant at 5% level of significance. Intercept is insignificant. Significance of the coefficient of trend shows existence of Deterministic Trend.

Testing for Seasonality

But it might be the case that the unit root inference of the ADF Test is due to presence of seasonality. Hence, we first carry out the test for seasonality to confirm if the unit root truly exists by incorporating **dummy variables**. For monthly data, an intercept term, 11 dummy variables and trend have been included in the model and regression is to run with the null hypothesis that the seasonal dummies are equal to zero. Let $SEAS_i$ be the dummy variable for i^{th} month w.r.t. the benchmark month December. Hence the model to be estimated by the OLS method is as follows –

$$y_t = c + dt + \Sigma_{i=1}^{11} d_i SEAS_i + a y_{t-1} + e_t$$

Running OLS we have reached at the conclusion that there is no evidence of presence of seasonality in the data. Rather there are evidences of presence of deterministic and stochastic trends. To de trend the data we use the method of differencing on ERIC series, the first difference of the data denoted as DERIC is

obtained as: $DERIC_{(i)} = ERIC_{(i)} - ERIC_{(i-1)}$, where ERIC stands for Exchange Rate of Indian currency. In this process we lose the first observation due to the method of first differencing.

ADF test to find the existence of Unit Root

We will again test for the presence of unit root in the differenced data using the ADF test. Here, the null hypothesis of presence of unit root has been rejected. The lag length 2 has been decided based on Schwarz Bayesian Criteria.

We have seen that the series is non-stationary at level value, and stationary at first differenced value.

Fitting a model for the stationary data series (DERIC) based on all observations

In order to estimate the model **Box-Jenkins approach** is used. The steps for this are :

- ***Identification*** – This involves determining the order of the model required to capture the dynamic features of the data. We first study the correlogram of the series DERIC. The study of ACF and PACF functions will give us an idea of the appropriate model.

The null hypothesis ($H_0 : \rho_k = 0$) has been rejected, *i.e*. ACF's are not declining and are statistically significant from zero for all lags up to the 36th lag. Hence, this cannot be a pure MA process. Here it is observed that the PACF is insignificant from 3rd lag onwards till the 17th lag and then again at 21st lag , 23rd lag and 31st lag.

ACF and PACF give us only tentative choices of order of MA (q) and that of AR(p). Thus from above analysis we can only conclude it cannot be a pure MA process and it can be an AR(2) model. However to find the more appropriate values of p and/ or q we will estimate our model on the basis of two information criterion – **Akaike's Information Criterion (AIC)** and **Schwarz Bayesian information Criterion (BIC).**

- ***Estimation* –** This involves estimation of the parameters of the model specified in step 1. Box and Jenkins suggests two methods: over fitting and residual diagnostics. Here we shall apply only the method of **over fitting**.

Over fitting: Here we can use AIC, BIC, AICC or Hall's Procedure to get the suitable model (if have more than one model). The model corresponding to minimum AIC and or BIC has been selected and then the next step is to check their residuals for the evidence of linear independence. If from the residual test we find that all the errors are not autocorrelated then we can conclude about that model being the most appropriate estimated model for the data. Considering all the above criterion we find **ARMA(4,4) to be the best estimated model** for the stationary series estimated **on inclusion of all the sample values**.

- ***Diagnostic checking* –** This involves model checking-that is determining whether the model specified and estimated is appropriate. Carrying out diagnostic tests on the error terms of the estimated ARMA (4, 4) model to verify whether they are really white noise (null hypothesis) terms or not with Ljung Box Q test statistic for the autocorrelation between lagged residual terms reveals that the Q statistic is insignificant. This implies that the model is an appropriate fit.

Obtaining the most appropriate model (AR/MA/ARMA) for an in-sample of size 80%

Proceeding in the same way, an appropriate model for the stationary series **DERIC1** (*i.e*. the series containing 80% sample values, from January 1975 to August 2001) has been estimated and the Estimating Equation for the data DERIC1 as:

$$DERIC1Y_t = 0.1229 + E_t + 0.1301E_{t-1}$$

The Diagnostic checking suggests that the error terms in Estimating Equation for the data DERIC1 are not white noise at 5% level of significance and hence the model cannot be taken as a good fit for the stationary series.

III. Forecasting and Looking for Structural Break

Then for finding forecasting performances of the estimated model and looking for structural break within the data the steps are : Finding both in-sample and out-sample forecast performances of the estimated model; Testing for single structural break.

Finding both in-sample and out-sample forecast performances of the estimated model

One of the important forecasting procedures is Holt Winters Forecasting Technique. It is applicable also to non-stationary time series including both trend and seasonality, even of higher order.

To check whether the forecast model is good or not we use different methods:

In-Sample Forecast: Root Mean Squared Error and Mean Absolute Error of in-sample forecast values are quite high implying our forecast model is not good.

Out-Sample Forecast: High values of Root Mean Squared Error and Mean Absolute Error also imply that the forecast model is not good. Hence we can conclude our forecast model is not good.

However, the **forecasting performance is better for the in-sample values compared to the out-of-sample values.** This could be because in case of the in-sample values, there is over-fitting, *i.e*. the very observations whose values are predicted are themselves used to forecast the values.

Test for structural break

If there is a shift in the level of the data generating procedure, *i.e*. if there is a structural break it should be taken into account in testing for unit root because the ADF and other tests may have very low power if the shift is simply ignored. Structural break's are of three types:

- **Permanent Change** referring to permanent change in the underlying parameter.
- **Slow Change** implying slow fall/rise in the underlying parameter over time.
- **Regime Switching** refers to variation of parameter in different regimes, say up/down a particular threshold.

Here **Quandt-Andrews Unknown Breakpoint Test** has been used to check for presence of structural break. 5% of the data has been trimmed on both sides. Since the best approximated model for the entire series is ARMA (4, 4) model, we carry out the structural break test using the ARMA (4, 4) model. On the basis of the result of the test,

the null hypothesis of no structural break cannot be rejected, *i.e*. the data generating process remains stable over the entire period.

Since we find that our series is stationary, we have to go no further and as such our analysis ends here.

IV. Findings and Conclusion

The series is non-stationary at level values. The series has seasonality at level values, though the non-stationarity at the level values cannot be attributable to presence of seasonality alone. The first difference of the series is stationary. The best model is an AR(2) model for the entire stationary series and a special AR(14) model including only the 1st, 2nd, 7th, 12th, 13th, 14th lags when 80% of the sample values are included of the stationary data series but **ARMA(4, 4) is the best estimated model** for the stationary series estimated **on inclusion of all the sample values.**

There does not exist any structural break in the series.

References

- G.E.P. Box, S.C. Hillmer and G.C. Tiao, *Analysis and Modelling of Seasonal Time Series, Washington D.C., U.S. Department of Commerce- Bureau of the Census, 309-334*, 1978
- G.E.P. Box and G.M. Jenkins, *Time Series Analysis, Forecasting and Control, San Francisco; Holden Day*, 1970
- A. C. Harvey, *Forecasting Structural Time Series Model and the Kalman Filter, Cambridge, Cambridge University Press*, 1989.

150th
Birth Anniversary
Celebration

LOWER SEX RATIO : A POSSIBLE CAUSE OF WEALTH HYPOGAMY

Tanusree Mishra [a*]

[a]*Department of Economics, Sister Nibedita Govt. General Degree College for Girls, Hastings House, Kolkata-700027*

Abstract

Hypergamy or Hypogamy of various nature affects marital stability. Here we have considered wealth hypogamy that is marrying somebody who has less wealth or less income. Here level of social status is measured through the stock of wealth. This paper attempts on this fact that a lower sex ratio which causes fewer woman for man, that might cause negative assortative matching, which in turn reflect wealth hypogamy for man. Here in this paper we have formulated the idea on the basis of the theoretical model of 'Matching with a continuum of agents' of Browning, Chiappori, Weiss (2010). From our theoretical model we find that the possible cause of wealth hypogamy for man is fewer woman.

Keywords: Hypogamy; Negative assortative matching; Sex ratio.

Introduction

Marriage is a socially, ritually, or legally acknowledged contract between a man and a woman that establishes an institutional arrangement for cohabiting based upon some rights and obligations. The agents who marry form an expectation of maximization of either utility or production of household produced goods subject to specific constraints. That is, the two agents involved are both consumers as well as producers. So it involves a bilateral exchange. Thus, the success or failure of this event depends on many factors.

Marital pattern is mainly of two types: Positive assortative matching and negative assortative matching (Becker 1974). Positive assortative matching refers to a positive correlation in sorting between the values of the traits of husbands and wives (matching of likes). Negative assortative matching refers to a negative correlation (matching of unlike). Further, negative assortative matching can be divided as: Hypergamy (woman marrying someone who is wealthy or of higher caste or social status than oneself) and Hypogamy (woman marrying someone who is of lower caste or social status than oneself) (Dalmia 2011).

Several marriage models have been formulated and through utility maximization, optimum equilibrium is established or efficient marriage market conditions formulated (Browning, Chiappori, Weiss 2010, Shoshana, and Grossbard-Shechtman 2002).

* Corresponding author : E-mail : tanushree.mishra84@gmail.com., Phone: 8583964807

ISBN : 978-81-933395-0-3

Panda and Agarwal (2005) established that marital violence in case of hypogamous marriages are much less. According to this study if the female had property ownership then the incidence of marital violence significantly low and this was validated by an empirical study based on a household survey in Kerala.

The present study concentrates on the association of a particular type of marriage pattern with the problem of falling sex ratio in India. Sex ratio can be a possible cause of creating a particular type of marriage pattern among potential marriage partner.

Review of Literature

The theoretical study of Browning, Chiappori, Weiss (2010) on marriage pattern and matching process provides a clear economic view of efficient matching in marriage market. In their research they have shown stable matching without transfers using the Gale and Shapley algorithm and later stable matching with transferable utilities at a fixed rate of exchange is explored using the Becker Shapley Shubik(1972) model. Transferable utility implies that if a partner possesses some negative traits then he/she can compensate it by reducing his/her private consumption to the partners benefit. Their algorithm, based on this model, developed that with transferable utility the unique assignment output is not on the diagonal. They have also developed model of matching with a continuum of agents with one dimension and with multidimensional matching. Their work on search theory along with assortative matching gives suitable idea about cost of time spent on searching mate and the assignment problem in matching. Anthony Rafetto (2013) finds that educational hypogamy has not increased along with the rise in education but divorce rates have increased. Educational hypogamy has negative effect on marital happiness but educational hypergamy has positive effect on likelihood of divorce. Work hypogamy has a positive effect on likelihood of divorce.

In this paper we have consider the case of wealth hypogamy among men. Wealth hypogamy can be a cause of marital instability. Since, if man of higher economic and financial status, measured in terms of accumulated or inherited wealth, married to a woman of lower socio-economic status, that is with less stock of wealth, may create inequality in their marital life, that is, matching of unlike will take place.

Model

Browning, Chiappori, Weiss (2010), used the marital trait 'Income' but here we have taken 'Wealth' as the only marital trait. And individual wealth are complement in the household output function.

That is assortative matching is positive.

Let the household output function h(x,y) is super modular. [Browning, Chiappori, Weiss (2010)]

A continuum of men whose wealth W_M are distributed on [0,1] according to distribution F (let).

A continuum of women whose wealth W_F are distributed on [0,1] according to distribution G (let).

The measure of all men in the population is normalized to 1. And the measure of women is denoted by μ.

According to positive assortative matching if a man with wealth W_M is married to a woman with wealth W_F then the set of men with wealth above W_M must have the same measure as the set of woman with wealth above W_F.

Thus, for all W_M and W_F in the set of married couples: (using the concept of Browning , Chiappori, Weiss (2010))

$$1-F(W_M)=\mu(1-G(W_F))$$

Hence, $W_M=\gamma\left[1-\frac{1}{\mu}\left(1-G\left(W_F\right)\right)\right]\equiv\gamma\left(W_F\right)$

Where, $\gamma=F^{(-1)}$,

$$W_F=\zeta\left[1-\frac{1}{\mu}\left(1-F\left(W_M\right)\right)\right]\equiv\zeta\left(W_M\right)$$

Where, $\zeta=G^{(-1)}\zeta$

Let all men are divided among two groups, one with wealth $\overline{W_M}$ and the other with wealth $\underline{W_M}$.

If μ = 1, the assignment matches men and women of the same quantile in their respective wealth distributions (using the concept of Browning, Chiappori, Weiss (2010)). The sex ratio μ and the differences in the male and female wealth distributions determine the husband's and wife's wealth for each pair that marries.

When μ =1, then all men and women are married.

When μ < 1, then no of women < no of men, hence all women are married.

Now let all women are divided into two groups having wealth $\overline{W_F}$ and $\underline{W_F}$.

Measure of all women having wealth $\overline{W_F}$ is denoted by $\overline{\mu}$ and measure of all women having wealth $\underline{W_F}$ is denoted by $\underline{\mu}$.

Now if $\mu<1$, then $\overline{\mu}+\underline{\mu}<1$

Thus, $\overline{W_F}+\underline{W_F}<1$

Now women having wealth $\overline{W_F}$ married to men having wealth $\overline{W_M}$. All women are married if there is scarcity of women *i.e.,* μ < 1, implying that men with wealth less than $W_M^0=\gamma\left(1-\frac{1}{\mu}\right)$ remain single. $\left[\underline{W_M}<W_M^0<\overline{W_M}\right]$

And $\overline{W_F}>W_M^0$,

$$W_F^0=\zeta\left(1-\frac{1}{\mu}\right)$$

But, $\zeta\underline{W_F}<W_F^0=\zeta\left(1-\frac{1}{\mu}\right)$

Where, $\zeta\underline{W_F}<W_F^0=\zeta\left(1-\frac{1}{\mu}\right)<\overline{W_F}$

Now men having wealth $\overline{W_M}$ got women having $\overline{W_F}$ but some men with wealth $W_M^0 < \overline{W_M}$ remain unmarried and some men with wealth $\overline{W_M}$ have become agreed to marry women with wealth W_F and ensure negative assortative matching which is in turn wealth hypogamy for them.

Conclusion

On the basis of the detailed analysis of 'Matching with a Continuum of Agents' by Browning, Chiappori and Weiss, we applied the idea of introducing wealth as the marital trait. And it gives an interesting result that lower sex ratio is a major cause of wealth hypogamy. If the economy considerably faces a scarcity of woman, wealth hypogamy for men may create the incidence of demand for dowry from women, which is definitely a major cause of marital instability and domestic violence. Further analysis will be done on empirical ground using suitable econometric technique for the justification of the above theoretical analysis.

References

- Martin Browning, Andre-Pierre Chiappori, Yoram Weiss, *The Economics of the Family*. Matching on the Marriage Market: Theory, Chapter 7, 2010.
- Alan Booth, David Jhonson, N. Jhon Edwards, Measuring Marital Instability. *Journal of Marriage and Family*. Vol.45, No.2, (387-394), 1983.
- S. Gary Becker, A theory of Marriage, Journal of Political Economy. *National Bureau of Economic Research (p.299-351)*, 1974.
- Anthony Rafetto, Marriage &Hypogamy: The effects of Hyper/Hypogamy on Female Marital Happiness and Divorce. *Quantitative Methods in the Social Sciences. Columbia University.* Master of Arts Thesis, 2013.
- Pradeep Panda, Bina Agarwal, Marital Violence, Human Development and women's property Status in India. *World Development* Vol.33. No.5 (823-850), 2005.

BETTER LIFE BEYOND GDP

Arundhati Bhattacharya [a*]

[a] *Department of Economics, Sister Nibedita Government General Degree College for Girls, 20B Judges Court Road, Hastings House, Alipore, Kolkata - 700027*

Abstract

It is now a well-accepted fact that Gross Domestic Product (GDP) suffers from serious limitations when measurement of current well-being of a nation is called for. Several tools have been developed over time seeking to assess national or regional wellness. 'Better Life Index (BLI)', inspired by the recommendations of the Stiglitz-Sen-Fitoussi Commission and introduced by the Organisation for Economic Co-operation and Development (OECD)' in May 2011, is one of them that deserve attention. The index, composed of 11 (eleven) topics or dimensions, attempts to capture entire elements that make human lives better. Also it has the merits of comparability and flexibility; countries, regions and even individuals can compare their nation's well-being with their counterparts ordering the topics according to their own preferences. This paper intends to portray an insightful review of the BLI, meant to overcome the drawbacks of GDP regime along with pointing out some methodological defects of the index.

Keywords: BLI; GDP, OECD; Well-being.

Introduction

Ever since the concept of Gross Domestic Product (GDP) is in its flourishing phase, it is being widely accepted and used (perhaps 'misused') as a tool for judging not only the economic growth but also social well-being and even standard of living of any region or country. From the very beginning of this practice, veteran economists (like, Simon Kuznets) have repeatedly warned that GDP is a *specialized* tool and treating it as an indicator of general well-being is inaccurate and dangerous. However, over the years economic growth, measured by GDP has become the *sine qua non* for the country's well-being and per capita GDP is frequently used to compare quality of life in different countries.

But for the last few decades, there is a growing consensus that GDP alone does not suffice to serve the purpose, rather it often furnishes an imperfect story which misguides the policy developers and hence need for alternative measure of well-being is being increasingly felt.

* Corresponding author : Email: aru.bhatta@gmail.com, Phone: 9143394943

ISBN : 978-81-933395-0-3

Following the recommendations of the Commission on the Measurement of Economic Performance and Social Progress, also known as the Stiglitz-Sen-Fitoussi Commission (2009), Better Life Index (BLI) has been developed by the Organisation for Economic Co-operation and Development (OECD) and is launched in May 24, 2011 on the occasion of its 50th anniversary. The index is designed by a Berlin based agency, Raureif GmbH in collaboration with Moritz Stefaner, Frank Rausch, Jonas Leist, Marcus Paeschke, Dominikus Baur and Timm Kekeritz. It is the first attempt to create an internationally comparable measure (of well-being beyond traditional and material measure like GDP) by which countries can assess their own performance in line with their preferences for better life.

Conceptual Framework

BLI enables to visualise and compare the key factors that are assumed to contribute to well-being in OECD countries. It's an interactive tool that allows one to see how countries perform according to the importance he/she gives to each of 11 topics (shown below in **Table 1**) or specific aspects that make for a better life. Each topic is built using one to four specific indicators, which are averaged with equal weights within each topic.

Table 1: Topics and General Well-being Indicators used in BLI construction

Aspects	*Topics*	*Explained by*	*Indicators*
Material Living Conditions	Housing	Housing conditions and spendings	• Housing Expenditure (Ratio to housing costs on households' gross adjusted disposable income) • Dwellings with basic facilities (Percentage of people with indoor flushing toilets in their home) • Rooms per person (Average number of rooms shared per person in a dwelling)
	Income	Household income and financial wealth	• Household financial wealth (Average total value of a households' financial assets (savings, stocks) minus their liabilities (loans)) • Household net adjusted disposable income (Average amount of money that a household earns per year, after taxes)
	Jobs	Earnings, job security and unemployment	• Job security • Personal earnings • Long-term unemployment rate • Employment rate

(Table continued to page 129)

(Table continued from page 128)

Aspects	*Topics*	*Explained by*	*Indicators*
Quality of Life	Community	Quality of social support network	• Quality of support network
	Education	Education and what one gets out of it	• Years in education • Student skills • Educational attainment
	Environment	Quality of environment (*e.g.* environmental health)	• Water quality • Air pollution
	Civic Engagement	Involvement in democracy	• Stakeholder engagement for developing regulations • Voter turnout
	Health	How healthy one is	• Self-reported health • Life expectancy
	Life Satisfaction	How happy one is	• Life satisfaction
	Safety	Murder and assault rates	• Homicide rate • Feeling safe walking alone at night
	Work-life balance	How much one works, how much one plays	• Time devoted to leisure and personal care • Employees working very long hours

Source: www.oecdbetterlifeindex.org

After consultation with the OECD member countries, the indicators of this composite index are chosen in a way that satisfies statistical criteria, such as relevance and data quality and captures the multidimensional character of well-being subject to country wise comparability.

Each country is represented by one flower, each topic by one of its petals. The length of a petal indicates the score of the respective country in that topic. If we add up all scores, we get a total score for each country. The higher the score, the higher the flower will rise.

Results

Relevant data are collected from National Accounts – OECD, United Nations Statistics, National Statistics Offices and Gallup World Poll (a division of the Gallup Organization). The result thus obtained is briefed in **Table 2** below :

Table 2: Country wise and Topic wise Comparative Statistics

Topics	Housing		Income		Jobs		Community		Education		Environment		Civic Engagement		Health		Life Satisfaction		Safety		Work-life balance	
*Countries**	*S*	*R*	*S*	*R*	*S*	*R*	*S*	*R*	*S*	*R*	*S*	*R*	*S*	*R*	*S*	*R*	*S*	*R*	*S*	*R*	*S*	*R*
Norway	7.5	3	4.2	15#	9.0	3	7.7	9	7.3	8	10.0	1	5.5	9	8.5	7	10	1	9.8	1	8.7	5#
Australia	7.4	4	5.2	7#	8.4	6#	8.5	5	8.0	4#	9.7	2#	8.6	1	9.4	2	8.9	8	7.2	18	5.9	24
Denmark	5.7	14	4.4	14	8.5	5	8.7	3#	8.2	2#	8.7	6	6.6	3#	7.8	11	9.7	3	9.5	3	9.1	2
Switzerland	6.2	11#	7.9	2	9.4	2	7.8	8#	7.6	6#	7.5	11#	3.4	18	9.1	3	9.9	2	9.7	2	7.6	12#
Canada	7.6	2	5.6	6	8.4	6#	8.0	7	7.2	9	7.9	9#	6.4	5#	9.6	1#	9.3	6#	9.0	6#	7.2	15#
Sweden	6.5	9	5.2	7#	8.1	9	7.3	11#	7.6	6#	9.5	3	6.4	5#	9.0	4	8.8	9	8.6	8#	8.5	6
New Zealand	6.9	6#	4.7	12	8.3	7#	10.0	1	7.1	10	8.8	5	6.4	5#	9.6	1#	9.3	6#	7.3	17	6.4	21
Finland	6.2	11#	3.7	16	7.8	11#	8.1	6	9.3	1	9.4	4	5.2	10#	7.3	13	9.4	5	9.4	4#	8.1	9
United States	7.9	1	10	1	8.4	6#	6.4	15	7.0	11	7.5	11#	6.5	4#	8.9	5#	7.3	13	7.5	15#	6.2	23
Iceland	5.3	15#	4.6	13	9.7	1	8.8	2	7.5	7#	9.7	2#	5.2	10#	8.6	6	9.6	4	8.8	7#	5.5	26
Netherlands	7.0	5	5.1	8	8.4	7#	5.4	21	7.3	8#	7.3	12	3.9	16#	8.3	8#	9.0	7	9.0	6#	9.4	1
Germany	6.2	11#	5.0	9	8.2	8	7.3	11	8.0	4#	7.6	10#	4.9	11	7.3	13#	7.9	11	8.4	9	8.4	7
Luxembourg	6.8	7	6.9	3	8.7	4	7.8	8#	5.3	20	6.8	13#	6.0	7#	8.1	10#	6.7	15	8.1	10	8.2	8#
Belgium	6.7	8	5.8	4	7.3	13#	5.6	20	7.5	7#	5.8	18#	7.1	2	8.1	10#	7.4	12	7.8	13	8.7	5#
Austria	5.8	13	5.2	7#	8.3	7#	7.4	10	6.9	12	7.6	10#	3.9	16#	7.7	12#	8.1	10#	9.1	5#	6.9	16
United Kingdom	6.1	12#	4.9	10	7.8	11#	7.8	8#	6.4	14#	7.9	9#	5.9	8	8.1	10#	6.0	18	8.8	7#	6.6	19#
Ireland	6.9	6#	3.1	18	7.1	14#	8.6	4	7.3	8#	8.0	8#	2.4	20	8.9	5#	7.2	14	8.6	8#	8.2	8#
France	6.2	11#	4.8	11	7.1	14#	6.0	18	5.9	17	6.8	13#	6.0	7#	7.7	12#	5.4	20	8.0	11#	9.0	3
Spain	6.1	12#	2.9	19	3.5	24	8.7	3#	5.5	19	6.0	17	4.2	14#	8.3	8#	5.5	19	9.1	5	8.8	4
Slovenia	6.1	12#	2.0	22	6.5	16	5.8	19	7.7	5	7.6	10#	4.1	15#	7.2	14	3.1	27	9.4	4#	7.4	14
Czech Republic	4.5	19#	2.1	21	6.7	15	6.5	14	7.6	6#	6.7	14#	4.6	12	6.3	18#	6.3	16	7.9	12	7.6	12#
Estonia	5.3	15#	1.6	25	6.4	17	6.4	15#	8.2	2#	8.0	8#	5.5	9	5.5	22#	2.7	28#	6.9	21#	7.8	11#
Japan	5.2	16	5.7	5	7.9	10	6.7	12	7.6	6#	6.7	14#	1.5	24	5.0	23	3.7	24#	8.0	11	5.4	27
Slovak Republic	4.0	22	1.7	24#	5.0	23#	7.3	11#	6.1	16	6.1	16	5.2	10#	6.5	17	4.7	22	7.1	19	7.5	13
Italy	4.8	17	4.2	15#	5.3	21	6.6	13#	5.1	21	4.5	25	4.2	14#	7.7	12#	3.5	25	6.9	21	7.8	11
Israel	4.5	19#	3.5	17	7.3	13	4.5	23	5.6	18	2.3	29	2.8	19	8.9	5#	8.1	10#	7.4	16	5.2	28
Poland	4.4	20#	1.7	24#	5.9	20#	4.7	22	8.1	3	5.8	18#	4.1	15#	5.9	20	4.1	23#	7.5	15#	6.7	18

(*Table continued to page 131*)

(*Table continued from page 130*)

Topics	Housing		Income		Jobs		Community		Education		Environment		Civic Engagement		Health		Life Satisfaction		Safety		Work-life balance	
Countries*	*S*	*R*	*S*	*R*	*S*	*R*	*S*	*R*	*S*	*R*	*S*	*R*	*S*	*R*	*S*	*R*	*S*	*R*	*S*	*R*	*S*	*R*
Korea	6.1	12#	2.5	20#	7.7	12	0.2	30	8.0	4#	2.9	28	6.1	6	4.7	24	3.3	26	7.6	14	5.0	29
Portugal	6.4	10	2.5	20#	5.1	22	4.2	24	4.6	22	8.2	7	1.6	23	5.5	22#	0.7	31	7.8	13#	6.8	17
Latvia	1.8	26	1.0	29	6.1	19	3.8	25	7.5	7#	6.4	15	4.2	14#	4.6	25	3.7	24#	6.1	24	6.6	19#
Greece	4.1	21	1.9	23	1.4	25#	3.5	27	6.2	15	5.0	23	3.7	17	8.2	9	2.7	28#	7.0	20	7.2	15#
Hungary	4.5	19#	1.5	26	5.9	20#	3.0	29	6.6	13	5.6	20	2.3	21	5.6	21	1.7	30	6.2	23	7.9	10
Russian Federation	4.7	18	1.3	28	7.1	14#	6.6	13#	6.4	14#	3.2	27	1.9	22	3.0	26	4.1	23#	4.2	26	8.2	8#
Chile	4.4	20#	1.4	27	6.1	19#	3.1	28	4.3	23	4.6	24	1.3	25	6.3	18#	6.1	17#	5.4	25	6.5	20
Brazil	3.5	25	0.6	32	6.2	18	6.3	16	1.9	26	5.1	22	4.3	13	6.6	16	6.1	17#	0.0	29	6.3	22
Turkey	3.8	24	0.7	31	5.0	23#	3.6	26	3.3	24	3.9	26	6.5	4#	6.7	15	2.3	29	6.8	22	0.0	31
Mexico	3.9	23	0.8	30	6.1	19#	0.0	31	0.7	27	5.7	19	6.6	3#	6.1	19	5.0	21	0.7	28	2.1	30
South Africa	1.6	27	0.4	33	1.4	25#	6.1	17	2.3	25	5.2	21	4.2	14#	2.9	27	0.0	32	3.3	27	5.7	25

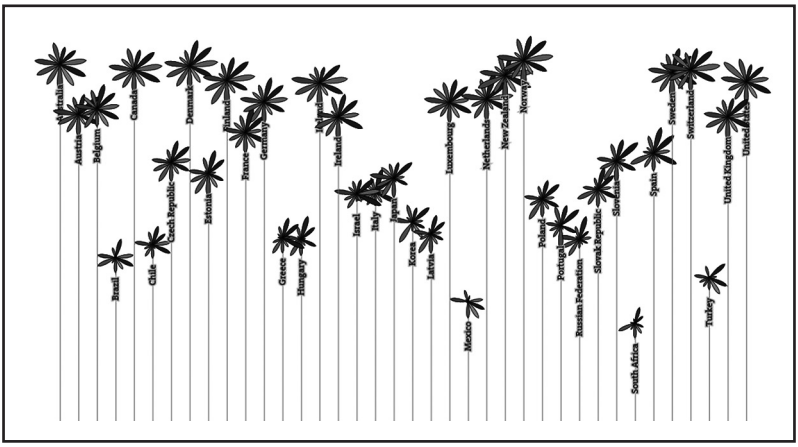
Source: www.oecdbetterlifeindex.org

**Countries are ranked according to BLI scores, S = Score, R = Rank of that country in the topic concerned*

 # Countries are joint rank holders

Brazil, Russian Federation and South Africa are not members of OECD

The following figure depicts a pictorial representation of ranking of OECD member countries:



Source: www.oecdbetterlifeindex.org; Brazil, Russian Federation and South Africa are not members of OECD

Fig. 1: Positional comparison of OECD member countries with respect to BLI.

Interacting users enjoy the privilege of changing the weights of the topics through web application. Putting greater weight on one of them will make the respective petal broader and more saturated, while the other petals will be taken back a bit. The resulting personal indices and rankings can be shared on the web and offer channels for further discussion, which provides the OECD valuable feedback and help to get in touch with people.

Some Emerging Issues

Although BLI serves its purpose of catering a tool that is far improved from the very conventional national measure, it is being questioned on the basis of following grounds:

- The problem of inequality in the society has not been addressed
- Some of the criteria are problematic and vague
- There is no attention to religion, good family life or moral formation. Spirituality, one of the important sources of 'better living' is completely ignored
- Some criteria that require inclusion, are omitted
- The aggregation technique constrains the possible ranking of the countries

BLI, targeted to promote '*better policies for better lives*' is still in stage of infancy and undergoing modification and upgradation. We are hopeful that in future editions, it will appear as a comprehensive tool for measuring, as well as for comparing countries' well-being.

References

1. J.C.J.M. Bergh, "Abolishing GDP", Tinbergen Institute Discussion Paper, 2007.
2. R. Costanza et al. (2009), "Beyond GDP: The Need for New Measures of Progress", The Pardee Papers, 2009.
3. M. Durand and C. Smith, "The OECD Better Life Initiative: How's Life? and the Measurement of Well-Being", Paper Prepared for the IARIW Session at the 2013 World Statistics Conference Sponsored by the International Statistical Institute, 2013.
4. M. Heloisa, "Measuring Economic Progress and Well-Being: How to Move Beyond GDP?", Oxfam America Research Backgrounder Series, 2012.
5. A.F. Ivkovic, "Limitations of the GDP as a Measure of Progress and Well-being", Econviews, God. XXIX, BR. 1/2016, 257-272, 2016.
6. J. Kasparian and A. Rolland, "OECD's 'Better Life Index': Can Any Country be Well Ranked?", Journal of Applied Statistics, 2012.
7. P. Maro, "Ideas for Overcoming the Limitations of GDP as a Progress Indicator", EEB Briefing Document, 2007.
8. www.oecdbetterlifeindex.org.

ISBN 9788193339503

www.snggdcg.ac.in

Books available at